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INDEX TO VOLUME X.

OCTOBER, 1895-MARCH, 1896.

The titles first appearing under each classification head are those of leading articles in the Magazine. The titles in smaller type, which follow, indicate articles from other journals which have been editorially noticed in the "Review of the Engineering Press." The asterisk (*) marks the occurrence of illustrations.

ARCHITECTURE AND BUILDING.

PAGE.

ARCHITECTURAL STUDENTS' WORK ABROAD. . . *R. Phené Spiers.* 33

CONTEMPORARY ENGLISH ARCHITECTS AND THEIR WORK. . . . . *H. Heathcote Statham.* 203
With 17 Illustrations.

SCHOOLS AND SCHOOL-HOUSE ARCHITECTURE. . . *E. C. Gardner.* 478
With 25 Illustrations.

THE VALUE OF GOOD ARCHITECTURE IN CITIES. . *Barr Ferree.* 671
With 12 Illustrations.

ARCHITECTURAL SCULPTURE IN AMERICA. . . *Russell Sturgis.* 883
With 15 Illustrations.

THE ARCHITECTURE OF MODERN BANK BUILDINGS, *R. W. Gibson.* 1064
With 5 Illustrations.

REVIEWS.

AMERICAN Architecture, John Stewardson on.................................1101
Architects, Origin of, Herbert Spencer on....1102
Architects, The Twenty-ninth Annual Convention of the American Institute of.... 505
Architectural Training.................... 304
Architecture, A Professor on.............. 711
Architecture at the Seaside............... 307
Architecture in London.................... 104
Beaux Arts Society of Architects, The...... 916
Boston Public Library, The............... 1101
Bricks, Colored.......................... 106
Building Laws of Byzantium, The.......... 105
Cathedral of St. John the Divine, Foundations of the......................... 103
Church Designs, Some Recent.............1103
Columns, Cast-Iron, The Use of in Building 507
Concrete Floors.......................... 308
Design, Modern Building.............. 710
Designs, Some Recent Church.............1103
Exposition, the Paris, for 1900............1105
Fire-Escapes, Faulty............ 507
Floor Tests, Austrian..................... 302
Halls, Convention........................ 506
High Buildings and Fires............. .. 917
Hunt, The Late Richard Morris.......101, 709
Illustrations, Index to Architectural........ 505
Illustrations, Index to.....510, 718, 923, 1109
*Illustrations of the Month [criticisms] 508, 712, 917, 1105
Library, The Boston Public...............1101
Mathematics and Construction in the Ecole des Beaux Arts..................... 306
Municipal Control of Buildings............ 915
Origin of Architects, Herbert Spencer on the1102
Paris Exposition for 1900, The... 1105
Scenic Art, A Painter on................. 916
Spencer, Herbert, On the Origin of Architects1102
Stewardson, John, On American Architecture1101

INDEX to leading articles in the Architectural and Engineering Press...................106, 308, 511, 719, 924, 1109

CIVIL ENGINEERING.

[*For additional Civil Engineering, see Railroading and Municipal Engineering.*]

PAGE.

THE NEWHOUSE TUNNEL AT IDAHO SPRINGS. . *Arthur Lakes.* 49
With 12 Illustrations.
UNDERFLOW AS RELATED TO IRRIGATION. . . . *H. V. Hinckley.* 84
WILL A BRIDGE ACROSS THE HUDSON RIVER PAY? *Gustav Lindenthal.* 261
THE PIKE'S PEAK AND COLORADO SPRINGS WATER WORKS. . . . . *Arthur Lakes.* 271
With 10 Illustrations.
AN ENGINEER'S LIFE IN THE TROPICS. . . . *Charles P. Yeatman.* 632
With 20 Illustrations.
THE LOCATION AND CONSTRUCTION OF DAMS. . *J. B. Johnson.* 654
With 11 Illustrations.
THE LAW OF WATER AND MODERN IRRIGATION. . *Richard J. Hinton.* 699
LOCATING A PUBLIC WATER-SUPPLY. . . . *Daniel W. Mead.* 876
THE FREE-PORT OF COPENHAGEN. . . . . . *P. Vedel.* 899
With Map and Plans.
STANDPIPES FOR FIRE PROTECTION AND STREET FLUSHING. . . . . . . *Louis L. Tribus.* 1040

REVIEWS.

Brick Paving, Specifications for........... 726
*Bridges Iron, Recording Vibrations in.....1113
Brick, Tests of Paving.................... 513
*Bridge Specifications, Union Pacific Railroad for 1895........................ 722
Canal, Montreal, Ottawa, and Georgian Bay. 724
*Canal Nicaragua, The Report of the Commission.......................... 930
*Canal, The Chicago Drainage............ 515
Canal, The Panama...................... 111
Cement, Heat Tests for................... 514
*Cement, the Specific Gravity of.......... 311
Clay, Pipe Line for...................... 114
*Column Foundations, Elevated Railroad... 314
*Concrete Work, Rules for................ 925
Construction Standards.................. 518
Disaster, The Ireland Building............ 109
Dredge, A Large Bucket.................. 111
*Dredge, An Enormous Suction........... 928
*Dry Dock, The Port Royal............... 513
Duties of the Engineer to the Public....... 1118
Fire Department, Organization of a........ 725
Fire, Prevention of...................... 723
Flow of Water in 48-In. Pipes.............1112
Highways, Maintenance of...............1118
Hydraulic Formula, A Simple.............1115
Inland Navigation—Germany............. 108
Interstitial Space........................ 312
*Iron Bridges, Recording Vibrations in.....1113
Lakes, The Effect of Artificial Diversion Upon the Commerce of the............... 114
Maintenance of Highways...............1118
*Mantle, The Villa, for Protecting River Banks...........................1116
Rivets, the Resistance of................ 314
Road, The Great Sheridan............... 111
Ship Canal from Lake Erie to the Hudson, A. 310
Simple Hydraulic Formula...............1115
*Standard Structural Shapes.............1116
*Structural Shapes, Standard.............1116
Structural Steel, Standard Specifications for.. 112
Subway Traction in Chicago.............. 315
Timbers, Strength of Bridge and Trestle.... 517
Timbers, Tests of Commercial............. 518
Tubular Structures...................... 313
*Tunnel, The Simplon................... 926
*Vibrations in Iron Bridges, Recording.....1113
*Villa Mantle, The, For Protecting River Banks...........................1116
Water, Flow of in 48-In Pipes.............1112
Water Power, Its Generation and Transmission.......................... 729

INDEX to leading articles on Civil Engineering in the Engineering Press, including Bridges, Canals, Rivers and Harbors, Hydraulics, Irrigation and Miscellany..........114, 315, 519, 726, 932, 1119

DOMESTIC ENGINEERING.

SCHOOLS AND SCHOOL-HOUSE ARCHITECTURE. . . *E. C. Gardner.* 478
With 25 Illustrations.
LIGHTING RESIDENCES BY ELECTRICITY. . . *Augustus Noll.* 1061

REVIEWS.

Acetylene, The Poisonous Qualities of.... 729
Air Gas and Incandescent Lights.......... 731
Bacteria in Water From Deep Wells........1122
Baths and Water Closets........ 1123
Boiler Explosions, Domestic............... 936
*Damage to Buildings by Vegetable Growths. 937
Drying Rooms...... 935
Electric Heaters, Efficiency of... 321
Electric Heating, More About.......... .. 732
Fires Caused by Heating Pipes............ 523
Fires from Steam Pipes................... 732
Gardening, Unnatural. 319
Gas, An Alleged Remarkable Discovery in.. 119
Gas Bills, How to Reduce................. 522
*Gas Burner, A New 1124
Gas Consumption, Effects of Upon the Health 117
*Lamp Globe, A New...................... 730
Lead vs. Iron Pipes in Plumbing..........1121
New Gas Burner, A.......................1124
Plumbing, Sanitary.... 116
Sanitary Education of the Public in Michigan. 937
Schools, Ventilation and Heating of........ 118
Steam Coils, Removing Air From.......... 524
Testing House Pipes and Drains........ .. 318
Ventilation of Gas-Lighted Rooms......... 521
Water Closets and Baths..................1123
Water Filtering, Domestic......... 934
Water from Deep Wells, Bacteria in.......1122
Water Supply, Superabundant............. 321
*Well Experience, An Interesting... 935

Index to leading articles on Domestic Engineering in the Engineering Press, including Heating and Ventilation, Landscape Gardening, Plumbing and Gas-Fitting, and Miscellany.........120, 322, 525, 732, 938, 1124

ELECTRICITY.

PAGE.

The Future of the Electric Telegraph. . . *Patrick B. Delaney,* 39
Future Methods of Sewage Purification. . *W. L. Hedenberg.* 76
The Distribution of Power in Collieries. . . *Llewelyn B. Atkinson.* 236
The Limits of Electric Power Transmission. . *Alton D. Adams.* 269
The Distribution of Electric Power at Niagara. *Franklin L. Pope.*
Ralph W. Pope. 407
Are We Educating Too Many Electricians? . *Henry Floy.* 649
The Commercial Exploitation of Electricity. *Burton E. Greene.* 845
Lighting Residences by Electricity. . . *Augustus Noll.* 1061

REVIEWS.

*Arc Lamp, the Jandus................... 738
*Arc, Ventilated, Inclosed................1128
Better Construction Work Wanted......... 323
Braking of Trolley Cars, The............. 326
*Calculagraph in Telephone Service, The... 941
Canadian Telegraph Lines................. 737
Channel Buoys, Electrically Lighted....... 123
Chicago-St. Louis Air Line, The.......... 121
Chronograph for Trolley Roads............ 944
Direct vs. Alternating Currents........... 939
Dry Batteries....... 944
Electrotytic Action, Preservation of Gas and
Water Pipes from.......................1126
Electric Railway Problems................ 122
Electric Railway, The Liverpool.......... 126
Electric Railways, Freight Traffic on....... 124
Electric Traction at the Railway Congress... 126
Exhibition, National Electric..............1131
Fuse Wires, Rating and Behavior of........ 735
Gas and Water Pipes, Preservation of, from
Electrolytic Action.....................1126
Glow Lamps, German Report on..........1129
Incandescent Street Lights................ 126
Monocyclic Electrical Distribution......... 328
Municipal Electricity..................... 325
National Electric Exhibition...............1131
Non-Magnetic Electric Devices............ 126
Poles, Wires, and Shade Trees............ 122
Postal Telegraph System, The English... . 527
Power Transmission, Modern............. 125
Preservation of Gas and Water Pipes from
Electrolytic Action.................1126
Present Status of the Storage Battery.......1131
Report, German, on Glow Lamps..........1129
Storage Battery, Present Status of..........1131
Storage Batteries in Telegraphy............ 328
Storage Batteries Score Victories... 734
Storage Battery as a Motive Power, The.... 123
Telephone Systems, Adequate............. 529
Telephone vs. Telegraph................. 530
Telephonic Improvements, New........... 943
Tesla Patents, The......... 327
Transformer Economy.................... 125
Underwriters, National Board of Fire....... 740
Unit Fever, The.......................... 125
Vehicles, Self-Propelling Road.... 122
Velocity of Projectiles, Measuring The...... 124
Voltage, The Question of Higher.......... 526
*Ventilated Inclosed Arc.................1128
Water and Gas Pipes, Preservation of, from
Electrolytic Action.............. ...1126
Wiring, Induction in House............... 124
Wiring of Buildings, The................. 121

Index to leading articles on Electricity in the Engineering Press, including Lighting, Power, Telephony and Telegraphy, and Miscellany...127, 328, 531, 740, 945, 1131

INDUSTRIAL SOCIOLOGY.

		PAGE.
The Cuban Revolt: Its Causes and Effects.	*A Native Cuban.*	9
The Currency Problem and its Solution.	*Abraham Mills.*	187
Taxation in the United States..	*Edward Atkinson.*	194
Money and Banking.	*Horace White.*	391, 597
I. First Principles and the Gold Standard.		
II. Representative Money and Gold Exportations.		
Side Lights on the South African Gold Boom.	*Albert Williams, Jr.*	399
Cripple Creek Gold Mines and the Stock Boom	*T. A. Rickard.*	605
Jingoism, or War Upon Domestic Industry.	*Edward Atkinson.*	801
Trade and Industry of South America.	*Emilio M. Amores.*	811
The Money Question and Constructive Enterprise.	*John R. Dunlap.*	1005
The Scotch System of Branch Banks.	*J. Selwin Tait.*	1014

REVIEWS.

Air, No Legal Right to........ 133
An Important Lesson........ 953
Associations, Rural Loan, in Germany......1137
British Commercial Supremacy Ended...... 535
Business Men and Social Theorists.........1136
China, Labor and Wages in........1139
Coöperation Successful........ 333
Cotton Mills in the Southern States......... 952
Deficits in the Bank of New Zealand....... 338
Education of the Negro........1135
Employer and Employee under the Common Law........ 746
Employers and Employed, The Relations of. 130
Employers, Liability of for Injuries to Workmen........ 134
Export Trade, Prospects for American with Japan........ 749
Government Appropriations for the Maintenance of Commerce........ 536
How Work People are Housed in Berlin.... 538
Inheritance of Property a Social Evil....... 336
Labor and Wages in China........1139
Labor Questions, Sundry........ 748
Loan Associations, Rural, in Germany......1137
Misdirected Effort........ 135
Municipal Ownership........1138
Municipal Progress and the Living Wage... 131
Negro, Education of........1135
Old Age Houses in Austria........ 334
Old Cities, Reconstruction of 539
Ownership, Municipal........1138
Physics and Sociology........ 750
Plutocracy and Patriotism........ 744
Profit-Sharing, Both Sides of........ 948
Rural Loan Associations in Germany.......1137
Silver, The Upward Moving of 540
Social Theorists, Business Men and 1136
Wages and Labor in China........1139
Wages in France........ 335

Index to leading articles on Industrial Sociology in the Engineering Press and Current Reviews. 135, 338, 541, 750, 954, 1140

MARINE ENGINEERING.

		PAGE.
International Racing and National Supremacy on the Sea.	*W. P. Stephens.*	1
The Transatlantic Steamers of 1856 to 1880. With 14 Illustrations.	*Samuel Ward Stanton.*	245
The Great Modern Transatlantic Steamships. With 19 Illustrations	*Samuel Ward Stanton.*	447

REVIEWS.

Battleships, New Double Turret........ 140
Bessemer Steel in Shipbuilding........ 137
Boilers, Marine, Care of........1146
Capital, Destruction of, in Substituting New for Old Appliances 141
Care of Marine Boilers 1146
*Electric Communication with Battleships.. 139
Electrical Canal Boat Towage........ 343
Engineers' Strike at Belfast and on the Clyde1146
Evaporative Power of the Belleville Boiler... 753
Hydroplane, The........ 755
Kiel, The Coming Exhibition at........ 958

Lake Shipbuilding Industry, The........... 545
Lakes, The Great American, Shipbuilding on. 1143
"Le Goubet" No. 2, The Submarine Boat.. 1145
Lights on the Ocean.................... 138
Marine Boilers, Care of..................... 1146
Naval Engineers, Education of............. 341
Oriental Engineering and Shipbuilding...... 544
Shipbuilding, German..................... 950
Shipping on the Great American Lakes 1143
Submarine Boat "Le Goubet" No. 2...... 1145
"Terrible," The British Warship...... .. 140
*Tests of Wound Copper Pipes.... 342
Tubular Boilers in the French Navy....... 754
Waste and Supply of Shipping............. 756
Water-Tube Boilers for Marine Service..543, 956
Wharf Improvement at Birkenhead......... 344

Index to leading articles on Marine Engineering in the Engineering Press and Current Reviews.
141, 344, 547, 756, 956, 1146

MECHANICAL ENGINEERING.

PAGE.
Racial Traits in Machine Designing. . . *Albert Williams, Jr.* 92
The Prevailing Scarcity of Skilled Labor. . . *A. E. Outerbridge, Jr.* 227
Education of Mechanical Engineers:
I. Aim and Scope of the Engineering Colleges. . . . . . . *R. H. Thurston.* 418
II. The Bearing of Shop Practice. . . *Charles E. Emery.* 423
III. Value of the Manual Training Schools. *A. E. Outerbridge, Jr.* 428
With 14 Illustrations.
The Manufacture of Steam. . . . . *A Staff Writer.* 500
A Piece-Rate System and Shop Management. . *Fred. W. Taylor.* 690
Limits and Possibilities of the Gas Engine. . *George Richmond.* 853
Artistic Engine-Room Interiors. . . . *E. T. Adams.* 1046
With 7 Illustrations.

REVIEWS.

Index to leading articles on Mechanical Engineering in the Engineering Press, classified under the Machine Shop, Steam Engineering, and Miscellany.................................147, 351, 552, 763,

Accuracy in Workmanship.............. 1148
*Belt-Lacing, Experimental Study of....... 347
Boilers, Heating Surface of, The...........1150
*Butter-making Machine, A New Swedish.. 762
Design and Testing of Fans, The..........1150
Designing Machines...................... 533
Economies in Foundries, False............ 350
Electric Arc Welding.....................1152
Electric Traveling Crane, The Modern. 967
Electric Welding—Another New Process. .. 550
Engine, The Willans......................1153
Engine Foundations..................... 144
Ethics for Draftsmen..................... 961
Fans, Design and Testing of, The 1150
Gas (coal) as Motive Power for Self-Propelling Road Vehicles... 349
Gearing, Worm.......................... 761
Heating Surface of Boilers................1150
Horseless Carriage, The................. 552
Lignum Vitæ Bearings.................... 146
Mechanical and Unmechanical Devices..... 552
Mechanical Flight 761
Metal, A New-Tempered Wrought Iron... 965
*Plumb Bobs, A Word About............. 350
Steam Boilers, The Efficiency of Heating Surfaces in.....................143, 759
Steam Pipes and Steam Joints for Marine Use............................. 548
Steel Castings, Progress in.... 346
Terminology, Manufacture of... 142
*Valve for Steam Pipes, New Isolating..... 962
*Water-Tube Boilers, Circulation in... 963
Welding, Electric..................550, 1152
Willans Engine, The....................1153
Wind as a Motive Power in the United States 146
Workmanship, Accuracy in................1148
Yost, George W. N., Death of........... 351

MINING AND METALLURGY.

PAGE.
The Newhouse Tunnel at Idaho Springs. . *Arthur Lakes.* 49
With 12 Illustrations.
Mountain Railroads of the Mining Regions. . *James R. Maxwell.* 61
With 17 Illustrations.
The Distribution of Power in Collieries. . *Llewelyn B. Atkinson.* 236

SIDE LIGHTS ON THE SOUTH AFRICAN GOLD BOOM. . *Albert Williams, Jr.* 399
CRIPPLE CREEK GOLD MINES AND THE STOCK BOOM. *T. A. Rickard.* 605
THE FUTURE OF THE AMERICAN IRON TRADE. . *James M. Swank.* 613
GOLD MINING IN THE SOUTHERN STATES. . . *H. B. C. Nitze.* 821
With 19 Illustrations.
PROSPECTING WITH THE DIAMOND DRILL. . . *J. Parke Channing.* 1075
With 12 Illustrations.
PRACTICAL ASSAYING AT MINES AND WORKS. . . *H. Van F. Furman.* 1093

REVIEWS.

ALUMINUM Solders 559
Briquette Plant, A Belgian 155
Coal, Compressed, for Heating 972
Coal Conveyor, A Flume 559
Coaldust Fuel 769
*Coke-Oven, The Semet-Solvay 769
Coolgardie Gold Fields, The 1161
*Crusher and Pulverizer, A Dry 561
Electrical Mine Haulage 560
Engineers, Consulting 154
Erhardt Process for Tubular Boilers 761
Etching Tests for Iron and Steel 1162
*Explosives, Comparative Effect of 356
*Fuel, Feeder for Powdered 1158
Fusibility of Sand for Furnace Bottoms 1160
Gold and Silver Production, The World's 152
Gold Fields, The Coolgardie 1161
Gold Mines, The Trouble With Our Southern 151
Gold Production, The Cause of Increased 770
Illuminants Used in Mines 150
*Indicator Veins 973
Iron and Steel, Etching Tests for 1162
Iron and Steel Manufacture, The Development of 562
*Iron Blast-Furnace Practice, Development of 974
Iron, Crystallization of 154
Iron Industry and Germany and England, The 355
Kaffir Craze, The 557
Laboratories, Equipment of Mining and Metallurgical 153
Legislation Against Mining Stock Brokers 354
Low Grade Ore, Treatment of 1157
Mine Tunnels, Three Colorado 358
Mining Boom in Sight? Is an American 557
Mining Schools of Germany, The 767
Open-Pit Mining 359
Ore, Low Grade, Treatment of 1157
*Powdered Fuel, Feeder for 1158
Phosphate Mining, Florida Pebble 771
*Placer Mining, Colorado 971
Rand Conglomerates 766
Russell Process, The 1159
Sand, Fusibility of, for Furnace Bottoms 1160
Steel Girders in Mines, Use of 354
Steel, New Method of Hardening 152
Treatment of Low Grade Ore 1157
Tungsten, the Place of in the Industries 357

INDEX to leading articles on Mining and Metallurgy in the Engineering Press 156, 360, 562, 771, 977, 1163

MUNICIPAL ENGINEERING.

PAGE.
FUTURE METHODS OF SEWAGE PURIFICATION. . . *W. L. Hedenburg.* 76
THE PIKE'S PEAK AND COLORADO SPRINGS WATER WORKS. . . . . *Arthur Lakes.* 273
With 10 Illustrations.
THE INVESTIGATION OF PUBLIC WATER SUPPLIES. . *Floyd Davis.* 439
THE VALUE OF GOOD ARCHITECTURE IN CITIES. . *Barr Ferree.* 671
LOCATING A PUBLIC WATER SUPPLY. . . . *Daniel W. Mead.* 876
STANDPIPES FOR FIRE PROTECTION AND STREET FLUSHING *Louis L. Tribus.* 1040

REVIEWS.

BURNERS, Welsbach, at San José, Cal 161
Carbid of Calcium Industry 1169
Catchbasin for Large Flows 983
Conduit, a Sixty Inch Steel 569
Computation Table for Flow in Sewers 1166
Electrolytic Action, Injury to Pipes by 570
Freezing in Pipes, Prevention of 780
*Gas Mains, Delivering Capacity of 1168
Lighting, Recent Improvements in 307
Nitrites in Water, Determination of 1166
*Oxid, Cleansing Spent 982
*Pavements, Asphalt 162
Pavements, Sanitary 163
Paving Bricks, Specifications for 164
Paving Brick, Vitrified 307

Plumbers, Registration of Proposed in England..... 985
Purification Boxes (Large) Without Water Lutes..... 568
*Sand-Washer, the Hudson Waterworks... 366
Sewers, Computation Table for Flow in.....1166
Sewage, Electrical Purification of.......... 778
Sewage, The Hermite Process of Purifying.. 368
Sewer Construction in Water-Bearing Soils.. 777
Smoke Prevention........................ 981
Street Cleaning in New York city 164
Street Subways in Large Towns.......... 160
Trolley Cars on the New East River Bridge, New York 1170
Water, Determination of Nitrites in.........1166
Water Meters, Testing.................. 364
Water, Purification of by the Archbutt-Deeley Process........................ 984
Waterworks System of Toronto............ 368

INDEX to leading articles on Municipal Engineering in the Engineering Press, classified under Gas-Supply, Sewage, Streets and Pavements, Water-Supply, and Miscellany....................164, 368, 570, 781, 985, 1170

RAILROADING.

		PAGE.
MOUNTAIN RAILROADS IN MINING REGIONS. . With 17 Illustrations.	*James R. Maxwell.*	61
THE MASSACHUSETTS RAILROAD COMMISSION. .	*William A. Crafts.*	286
THE COST OF RAILROAD CONSTRUCTION. . . .	*John F. Wallace.*	472
ARE AMERICAN RAILWAY RATES TOO HIGH? .	*H. T. Newcomb.*	624
RAILROAD ACCIDENT AND EMERGENCY SERVICE. . With 14 Illustrations.	*W. L. Derr.*	861
THE RAILROAD FACILITIES OF SUBURBAN NEW YORK .	*Foster Crowell.*	1029

REVIEWS.

AXLES, Maximum Flexion Point in....... 1178
Block Working, Principles of............ 168
Car Lubrication, Economy in.............. 577
Discipline Without Suspension............. 987
Dowing-Wheel Tires, The Wear of......... 167
Earthworks, Replacing Trestles With....... 786
Electric Locomotive, The Baltimore Tunnel. 373
Electric Road Power-House, Economy in An. 787
Electric Transmission....................1174
Emergencies in Railroad Work............1172
*Engines, Some Notable English.......... 990
European Railways, Mileage of...........1173
Fast Freight Lines, The Abolition of....... 578
*Fire-Box, The Docteur Brick-Lined....... 785
Flexion Point, The Maximum in Axles.....1178
Fuel and Water Supplies, Managing........ 376
Gas Street Railway in Dessau............. 371
Illumination Tests...................... 1177
Locomotives, Comparison of Compound and Simple 992
London to Aberdeen..................... 661
Long Distance Electric Transmission.......1174
Maximum Flexion Points in Axles.........1178
Mileage of European Railways............1174
Prussian Railways, Improvements on....... 784
Racing Across the Continent.............. 573
*Railroad Bridges, Solid Floors for........ 575
Railroad Cars, English and American...... 783
Railroad Work, Emergencies in...........1172
Railroads Making More Money........... 169
Railway Earnings, gross, for September.... 377
Railway Employees, Number and Classes of. 784
Railway Signaling, Present Practice in. 170
Railways, American and English Compared. 371
Railways (Light) in Hungary............. 992
Railways, The Condition of American...... 171
*Roadbed Construction for Street Railways..1174
Standards, Norfolk & Western System of Maintaining.................... .. 372
*Steel Sleepers.......................... 574
Street Railway Tracks Laid in Concrete.... 375
Street Railways in Chicago, Cost of Operating.............................. 993
*Street Railways, Roadbed Construction for.1174
Tests, Illumination......................1177
Tie-Plates, Metal...................... 374
*Track-Bolt Nut-Locks, Efficiency of...... 374
Train Speed Record Broken, The.......... 573
Tramway Motive Power 990
Tramway Progress in England, Lack of..... 169
Tramways, Gas Traction for 989
Tugs-of-War, Electric and Steam.......... 169
Uniformity in Car Construction Needed..... 170

INDEX to leading articles on Railroading and Street Railways in the Engineering Press, 172, 377, 578, 788, 993, 1178

MISCELLANEOUS.

THE CANADIAN LUMBER INDUSTRY. . . . . With 18 Illustrations.	*J. S. Robertson.*	17
FRANKLIN LEONARD POPE [OBITUARY.] . . With Frontispiece Portrait.		295

AN ENGINEER'S LIFE IN THE TROPICS. . . . . *Charles P. Yeatman.* 632
With 20 Illustrations.
OPPOSITION TO INVENTIONS. . . . . . *William C. Dodge.* 907
PROF. RÖNTGEN'S DISCOVERY OF A NEW RADIANCE . *Michael I. Pupin.* 1021
With 5 Illustrations.

REVIEWS.

ANOMALIES in Sanitation.................. 381
Brakes and Fenders for Trolley Cars.......1000
Bread, An Essential for Making Good...... 797
Birds in Flight and the Flying Machine..... 587
*Commercial Manufacture of Liquid Air and Oxygen.......................... 585
Contamination of Ice...................... 179
Critical Temperature and Boiling Temperature of Hydrogen....................... 384
*Electrical Measurement of Starlight....... 176
Engineering Magazine Index, The......... 183
Error Corrected, An...................... 183
Expired Air and Problems of Ventilation....1183
Fighting Forest Fires..................... 380
Fixation of Atmospheric Nitrogen.......... 175
Floating Sand...........................1185
Frauds in Textile Goods.................. 181
German Lamp, A New..................... 589
Globular Lighting.......................1001
Heating Feed Water for Marine Boilers 184
Haulage on Common Roads, Cost of....... 798
Injustice to Technical Men.... 792
*Iron Working in Ancient Egypt.......... 997
*Laboratory Still, A Convenient.......... 999
Maxim Flying Machine, The............. 177
Mildew, Its Cause and Prevention......... 796
Mining Under the Sea................... 184
Plans for Home Grounds................. 184
Preservation and Arrangement of Current Special Trade Literature............ 996
Ramie Fiber, Industrial Value of.......... 383
Romance of Modern Industry, A.......... 795
Rubber Supply, The Future............... 384
Sand, Floating..........................1185
Smokeless Powder, A New............... 588
Solar Magnetic Problem, The............ 584
Temperature, the Lowest yet Reached......1183
The Pearl Shell Fishery.................. 385
Topical Index. Wood Stave Pipe......... 183
X-Rays, The, Professor Röntgen's Discovery1181
Ventilation, Expired Air and Problems of...1183

INDEX to leading articles from the Engineering Press classified as Scientific Miscellany.
181, 385, 590, 789, 1002, 1188

BOOKS REVIEWED.

NOTES under this head appear on pages 185, 388, and 592.

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INTERNATIONAL RACING AND NATIONAL SUPREMACY ON THE SEA.

By W. P. Stephens.

THE great yachting contest of the year is marked by some extreme features which distinguish it from all previous international races; never before has so much money been expended on a pair of racing yachts, of no use whatever save to sail a series of five races. To state the case as plainly as possible, over $250,000 have been expended in a contest for the temporary possession of a piece of silver of little intrinsic value. Had this very large expenditure resulted in the production of two stanch and serviceable yachts, with a useful life of nearly a generation before them, the question might still be asked whether any public good results from such great outlay on articles of mere pleasure and luxury; and it becomes still more pertinent when it is considered that the two great yachts, Defender and Valkyrie, having served their immediate end of racing for the America's Cup, are no longer of any value. Their extreme draft—nearly 20 ft.—makes them useless anywhere but on the open sea, and their general model, construction, and cost of running make them racing machines, not convertible into useful cruisers. To those utilitarians who would answer the question with a prompt and emphatic negative, we would point out some phases of the history of American yachting and of international yacht racing.

When the foundation of what has since become a great system of international racing was laid in 1851 by the schooner yacht America through the winning of the cup offered by the Royal Yacht Squadron (which, by the way, was not a "Queen's cup," as it is so often called), the maritime interests of the United States were near the highest period

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of their prosperity, both technically and commercially. The great clipper ships, the Collins line of trans-Atlantic steamers, and the New York pilot boats brought fame to their builders and money to their owners. The great ship-yards of New York city were turning out some of the finest warships and ocean steamers then afloat,. and rivalled the ports of the Eastern States in their ocean clippers and coasting schooners. The interior of the country was as yet undeveloped, the great industries were close to the seaboards or the shores of the lakes, and the heart of the nation was with the sea.

Twenty years later, when the two British schooners, Cambria (1870) and Livonia, (1871) made the first efforts to regain the Cup, now established as a perpetual challenge trophy, there had been a sad change in maritime interests. Many causes—the introduction of the iron ship and the compound engine, the destructive effects of the civil war, and the more profitable field for capital offered by the internal development of the country and the construction of railways—had led the nation almost to forget and neglect the sea. The great shipyards were closed, their owners were dead, the American clipper sailed under a foreign flag, and the navy had dwindled to a few rusty iron monitors, and ironclads converted from the old wooden ships. From the great ocean greyhound down to the smallest tramp fruiter every ocean steamer that entered an American port was under a foreign flag. With peace at home and abroad, and with a magnificent railway system to carry the products of the interior to the seaboard, the nation at large, now covering almost the entire breadth of the continent, was indifferent alike to the need of a protective navy and to the humiliating absence from the seas of the Stars and Stripes. The astounding progress in science and engineering was limited to the land, and everything connected with naval design and marine engineering was neglected.

It was just at the turn of this state of affairs—some 15 years later, when the first movement for the building of a modern navy was under way, and when, through the efforts of a few, the people of the coast at least had begun to awaken to the importance of both a navy and a merchant marine under the American flag—that there came across the ocean a challenge to all American yachts from one of the finest representatives of the British cutter fleet. The development of yachting in America had been almost exclusively in the direction of the shoal centerboard sloop, while in Great Britain it had produced the narrow and deep cutter, such as the challenger, Genesta. Apart from the mere sentimental interest attaching to any contest between the representatives of two great nations, there were many technical points involved, of proportions, model, ballasting, centerboard or keel, sloop or cutter rig, construction and methods of handling,—points over which a lively controversy had already waged in America,—that added greatly to the interest and excitement of the races.

At first this interest naturally was confined to yachtsmen and the people of the coast; but, through that great medium, the press, the country at large was informed, first, of the fact that America and England were again engaged in a strife, though a friendly one; then, that the contest was not on land, but on the water; and, finally, that in it were involved important questions of supremacy in naval design, construction, and seamanship. To the inland reader, familiar at best with no other craft than a river steamer, if indeed he had ever seen water enough to float a catboat, the technical details at first meant nothing; but, as the months went on, and every detail of the construction of the Priscilla in New York and the Puritan in Boston was faithfully chronicled by the whole press of the country, the nation at large began to awaken to the fact that there was water outside of the United States, as well as mountains and prairies inside; that it was fighting on the water, though only in sport, against a foreign foe; and that some day it might be called upon to fight in earnest. The object lesson—and it was sorely needed—was thoroughly laid to heart; and when, in the fall of 1885, the news of the last great race and of the hardly won victory of the Puritan over the Genesta, and of the great triumph of Burgess, the modest American designer, was flashed over the land, among those who rejoiced most were many who had no definite idea of a yacht, but whose ignorance on this point in no way dimmed their joy over the national triumph.

The races of the next year, with the Mayflower, an improved Puritan, opposed to the Galatea, the newer and larger sister of the Genesta, awakened a still wider interest; and when, in 1887, this second victory was succeeded by a third,—of the Volunteer over the Thistle,—the whole nation shared in the triple triumph of Boston.

The far-reaching effect of this great series of international races has never been properly appreciated. The immediate effect was plain; a wider and deeper interest in yachting was awakened throughout the country, yacht clubs were formed in remote places, and in the old yachting centers a new enthusiasm was noticeable. Yacht building took on an unwonted prosperity, orders coming in for craft of all sorts, wood and steel, sail and steam. In design and construction very great advances were made as the result of the study of the foreign challengers, the new compromise yacht being safer, faster, abler, and far stronger than the old-time sloop. The subject of design received for the first time that attention which it deserves, and the importance of the professional yacht designer was generally recognized. A review of the yachts of 1888 beside those of 1880 would bear testimony to the vast improvement in every respect.

While the gain in such material points can hardly be over-estimated, it was but small compared with that in another direction. It was much to have produced a faster yacht than the old cutter, and a far safer yacht than the old sloop; but it was much more to have brought home to the people of the United States, without regard to locality or occupation, the great fact that the nation must, at any cost, maintain her supremacy upon the sea. This was the lesson of the Cup races of 1885, 1886, and 1887,—a lesson that is told anew with every fresh contest.

The work of equipping the navy of the United States with vessels of modern type began several years prior to the Puritan-Genesta races, a comparatively small sum of money being appropriated to the first vessels. Even this was given grudgingly; the farmer, the miner, and the merchant of the interior had no conception of the proposal to spend a million dollars or more in a single vessel, save as a job, nor were their representatives in congress inclined to be more liberal in providing an adequate coast-defence fleet. At a most opportune moment there came the challenge from the Genesta for the America's Cup, the work of preparation, the battle, and the victory appealing to the whole nation in the strongest way. The first interest of the inland American was awakened solely through his love of sport and a feeling of rivalry toward England; but, as one successful contest followed another, these gave place to a deeper feeling; the dormant love of the sea and pride in sea power inherited from sailor ancestors, but almost extinguished by purely inland pursuits, were at last aroused.

The result of this revival is seen to-day in the new navy of the United States, strong already in the possession of some of the finest vessels afloat, and growing year by year. The vast amount of money expended in the past 10 years in war vessels has come, not alone from the great cities of the coast within reach of the guns of a hostile fleet, but from the length and breadth of the nation. As a means to such an end, the construction of racing yachts of the highest possible speed can hardly be over-estimated, whatever their cost.

The immediate influences of the international races of recent years are many and far-reaching; the competition of the designers has resulted in a greatly improved construction, and in the production of greatly superior materials in the way of steel and other metals for hulls, of canvas for sails, and of wire rope as soft and pliable as cotton, yet with the strength of steel, for rigging, both running and standing. The tendencies of yacht designing under the stimulus of strong competition are varied, and not always of the best; the winner of one year may be such an ideal vessel as the Volunteer or the Minerva, while the next season may witness the triumph of such a racing machine as the successful Niagara; but with all this the advance in designing within the past 10 years is most marked. The old ideas and theories of yacht designing have given place to others far more in consonance with the laws of nature and the most advanced theories of scientists. The designing of yachts has passed from the hands of the builder to those of the trained yacht designer; the laws of stability and the value of proper ballasting—the two elements on which depend the safety of a yacht—are now generally understood and observed. The whole maritime world has been placed under obligations to the yacht designer and the racing yacht for the development of the peculiar form first embodied in the successful Gloriana, and for the accompanying theory of the use and value of a round and full waterline and diagonal in place of a hollow bow. First tested in yachts, this theory has been applied most successfully in the fast Sound steamers Richard Peck and Lowell, by Mr. A. Cary Smith, the yacht designer; and it is destined sooner or later to work a material change in the models of ocean vessels.

The advance in technical education in naval matters has kept step so closely with the recent progress in yachting that it is impossible not to associate them as effect and cause. Up to a very recent period the disregard of all that pertained to naval science was little less than a national disgrace; there was not an institution in the United States which taught the elements of ship designing and construction, and the few graduates of Annapolis who devoted themselves to these important branches were indebted to the courtesy of the British government for instruction in its naval colleges. The skill and craft of its shipbuilders, once a source of national pride in the days of Webb, Steers, Bell, and Eckford, were no longer recognized throughout the maritime world.

The condition of naval designing to-day is still far from satisfactory, but much has been done. Excellent technical instruction is given at Cornell University and other institutions, and the value of a thorough scientific training for the designer and marine engineer is now generally appreciated. It is in yachting that the greatest progress has been made; not only have the American designers, Burgess, Smith, and Herreshoff, shown themselves fully able to compete with those of other nations, but among yachtsmen at large there are hundreds of amateurs who have devoted themselves to the science of designing, who are qualified to discuss intelligently the design and construction of vessels, and who are fully alive to the great importance of such technical knowledge.

Much remains to be done; there should be within the reach of every ambitious boy the same opportunities for thorough instruction in naval design and marine engineering as have long been afforded in civil, mechanical, and electrical engineering and kindred professions. For more advanced students there should be one or more institutions fully equipped with the best instructors and the finest mechanical appliances, with suitable inducements and opportunities for those whose tastes run in the direction of experiment and investigation. As yet this country does not boast of one experimental tank for the trial of models by towing, though such are found in the private shipyards of England, apart from the magnificent government plant under the care of Mr. R. H. Froude. The necessity for advance in this line of work becomes more pressing each year, as the modern warship increases in cost and complication and the margin of profit in merchant vessels becomes smaller through competition.

Looking now from the ship to the sailor, the influence of the yacht races has served to bring many recruits to the ranks of yachtsmen, boat sailors, and canoeists ; and pleasure craft of some kind may be found wherever there is water, even in the most remote localities. The mere ownership and use of a boat, however small, is an earnest of a man's interest in the sea, and, multiplied by thousands, it becomes a material element of strength to a nation with such a sea-coast as ours The old type of yacht owner, trusting everything to his captain and indifferent to the technical side of the sport, has given place to the modern Corinthian, who rests not until he is fully posted on every detail of practical yachting, from the design and construction of his vessel to her handling in all emergencies. In the service of such owners are thousands of hardy tars, not all of American birth, most of them Scandinavians, but honest, capable, and fearless sailor men, born beside the sea, brought up in coasters and fishing smacks, and finding their way into American yachting after long sea voyages in all climes. Apart from their nationality,—and this is no serious practical drawback,—they form an immense reserve of experienced seamen, instantly available for use in time of war.

It is with the modern type of American yachtsman, keen, alert, and intelligent, that the new Naval Reserve originated, and from this type it derives its strength. Though yet a child in years, it is strong, vigorous, and rapidly growing, thanks to the firm foundation on which, after the failure of the first attempt in other hands, it was established by some New York yachtsmen. The value of practical yachting as a naval training school has already been demonstrated by the work of the Naval Reserve in its annual cruises, the members showing a remarkable aptitude and intelligence in work with the great guns, and other manœuvers in which they have had no previous practical experience.

That yachting has done much for the nation, and is now doing more, can not be denied ; what, then, has the nation done, and what should it do in return, if merely for its own benefit ? Like most independent Americans, the yachtsman is opposed to a paternal government ; he asks no coddling or special protection ; but he does ask to be let alone, so far as possible without conflicting with the general policy of the government This privilege, be it said, has not always been accorded to him in the past, and even now he is the victim of red tape and official meddling at times. It is to the credit of the nation that the attempt made a few years ago by some political partisans to hamper and annoy American yachtsmen by the imposition of absurd and unnecessary restrictions, such as denying to American owners the right to fly the national ensign on yachts of American build if under 5 tons, and similar unjust provisions, was an utter failure, resulting in even more liberty than before. There is still much that might be done, however, to relieve the yacht owner of useless restrictions which, though partly dead letters, are at times a source of serious annoyance at the hands of ignorant or dishonest officials. The laws relating to pleasure vessels might be very thoroughly amended, giving greater liberty to the yacht owner, with due regard to the necessary customs and health regulations ; and any such amendments should be framed, not in the hostile spirit of the so-called Frye bill, but with a view to promoting the building, ownership, and use of pleasure vessels of all types and sizes. In the way of direct government aid the yachtsman asks nothing ; from the very nature of the sport there can be no question of gain or profit connected with ownership of a yacht, and the owner is prepared to pay liberally for all that he receives.

The question of government aid to yacht owners, and of a return from them, has lately been brought forward through an article by Hon. Wm. McAdoo, assistant secretary of the navy, in the *North American Review*, in which is suggested a system of government supervision, with the consent of the owners, over steam yachts of the various classes, full-powered, auxiliary, and high-speed, with a view to their conversion into despatch boats and torpedo boats in time of war. Ingenious as it is, the plan is not likely to work in practice ; yachts of the largest class, such as the Electra, Sapphire, Sagamore, Columbia, and Nourmahal, with the smaller Wild Duck, Now Then, and Norwood, though very costly, lack the essential qualities of speed and endurance. One great element of their first cost—the magnificent furnishing and upholstery—would be practically thrown away at the start in the attempt to convert them into despatch or torpedo boats, leaving in most cases a hull of limited speed and bunker space, which could be strengthened and altered to carry the necessary armament only by a very large outlay. Such a change might be made satisfactory to the owner by the payment of a very large price for his yacht, but it could hardly be satisfactory to the government when the cost and character of the yacht-torpedo boat is considered. In the case of the fast launches, similar difficulties exist ; the boats are very costly and entirely too delicate for the proposed service.

While some of the difficulties disappear in the case of new vessels specially designed and constructed for this double use, there would still be the enormous expense, to be borne by one of the two parties, of the practical destruction of the entire interior fittings,—a very large item in the total cost of a steam yacht. This same question of costly furnishing would also bar the use of the yacht by the government for a short period each year,—an integral feature of the scheme.

A better solution of the problem may be found in the offering to yachtsmen of every possible encouragement to build and to experiment, to test new metals and other materials, and to indulge at their own expense in those costly experiments to which they are as a class inclined. At the same time all possible encouragement should be given to the advance of naval designing and to the improvement of building plants. The construction of a steel vessel 200 ft. in length is a comparatively simple and speedy matter to-day with good designs and an adequate plant ; a certain number of vessels are, or should be, immediately available in the event of a sudden emergency ; and, should the trouble be of long duration, others of the required types can be quickly built, at far less cost and of greater efficiency than any converted yacht.

THE CUBAN REVOLT: ITS CAUSES AND EFFECTS.

By A Native Cuban.

IT has been justly observed by Mirabeau that, when the people complain, they are always right. Now, the Cubans have been complaining bitterly, for a long series of years, of Spanish misrule and oppression, until to-day, as often heretofore, their patriotic protestations against the tyranny of a medieval monarchy find expression in the click of the rifle and the sharp clash of the sabre and *machete*. The evils at the root of this disaffection lie deep in Cuban soil, and have already yielded, and are now producing, their natural crop of rebellion, so-called treason, sanguinary battles, and—promises of reform! From the earliest dawn of the history of that beautiful, but unhappy, island, from the ill-starred hour when Velasquez invaded the land of Hatuey, from the days when liberty, naked and unfettered, roamed the hills and valleys of the new world, to this our own day, Cuba has lain under the iron rod of one of the cruellest of European oppressors. The Indian Cacique, whom Velasquez burned at the stake four hundred years ago, thought that paradise with Spaniards were worse than hell without them, and in this very hour the descendants of those same Spaniards, the very flesh and blood of the old race, have risen in their anger against the exasperating tyranny of their rulers; and, in the face of dreadful odds and utter, irretrievable ruin if unsuccessful, the patriotic band of Cubans in the field to-day will do or die in the cause of independence.

For some three hundred years the governor-general of Cuba has been the power that ruled the destiny of the people; his sway has been absolute; his command the law; and the same condition of autocratic authority practically exists at present. The governor is the commander of the army, and his commission is unrestricted. True it is that Cuba sends some representatives to the Spanish cortes, but, as they are there in a hopeless minority, it were better that they stayed away.

In 1836, a constitutional government was adopted for Spain, but Cuba did not share in the feast of liberty, meagre though it was.

Fearful of the effects of the growth of education, power, and wealth that Cuba would enjoy under the full measure of political justice to which, as a part of the kingdom, she was entitled, the Spanish government excluded Cuba from the operation of the constitution, declaring that she should be the subject of special laws. Those special laws meant martial law and a continuance of the old iniquities. It was then that Cuba, "the fairest jewel in the crown of Spain," began to lose its lustre and become dimmed with the shades of blood. Strenuous efforts, but unavailing, were made to bring about a satisfactory political status without severing the fanciful bond that united the island to the antiquated monarchy 5000 miles away; and at last, following the example of the American colonists, the banner of revolt was raised upon her plains, and for 10 long years an unrelenting warfare was maintained against the Spanish hordes. This struggle of an impoverished, oppressed, and poorly-armed people against a foe possessing every advantage which the Cuban lacked did not end, as would naturally be expected, in the defeat of the rebel, or, rather, the patriot army. No; peace was secured by Spain through General Martinez Campos, who made satisfactory *promises* of reform in accordance with the demands of the Cuban leaders. These promises were fulfilled in the Spanish manner, and Cuba will not, hereafter, entrust her destiny to the frail keeping of Spanish faith.

Since 1878—that is, for 17 years—the Autonomist party, composed of the most able andenlightened natives of the island, has been urging, in a respectful and peaceful manner, upon the step-mother-country the substantial fulfillment of the promises made by Campos in the name of Spain in 1878, relying upon which the revolutionists laid down their arms and returned to the paths of peace and slavery. But Spain, old, blind, and decrepit Spain, deaf to the pleadings of her own grand children, broke the pledges so solemnly made, although at the same time pretending to comply with the requirements of the Cuban people. The Autonomist party, so long as the people of Cuba were patient beneath its control, may fairly be said to have represented the majority of the inhabitants, but it ceased to so represent them the moment the people broke away from its guidance, and, as a representative party, it does not exist to-day. During its political life the Autonomist party, upon many occasions in the Spanish cortes, warned the government that it would not be responsible for any future attempt at rebellion by the disappointed Cubans; and, indeed, the Autonomists are in no wise responsible for the present uprising of their quondam political constituents.

The government system in Cuba is, and has always been, to the advantage of the Spaniard, and to the loss and detriment of the native, and consequently a hindrance to the material development of the industrial resources of the land. The tariff duties, the internal revenue taxation, the personal taxes, and the fees to custom house officials, together with the exasperating delays,—which can sometimes be avoided, also for a fee,—are all contrived to benefit the Spanish office-holder at the expense of the local native merchant. There is no civilized people on earth, with whose history we are acquainted, so heavily taxed as the unfortunate Cuban, nor is there a country on the face of the globe where the taxpayers have so little—in fact, absolutely nothing—to say regarding the governmental disposition of the money which they have paid. With Cuban funds, extorted from the pockets of the working people, Spain maintains an army and a navy like those of the United States, while a very small percentage of the revenues are disbursed for the education of youth. In fact, the expenditure of the island's revenues is the business of Spain ; all Cuba has to do is to furnish the money,—Spain does the rest. And it ought to be generally known, although it seems not to be, that every position upon the island in the gift of the government is bestowed upon Spaniards imported for the purpose of enjoying the emoluments of office. There it is not a question of political party among the natives, but one of conqueror and conquered ; the plums—rind, kernel, and all—are for the Spaniard, and nothing is left for the Cuban but submission or revolt. To every American, aye, to every man with a heart in its right place, revolt is better than submission to tyranny, and revolt has been the alternative chosen by the Cuban patriots. Under Spanish domination the industry and commerce of the island have been at their lowest ebb, and that Cuba has been at all able to bear the steady drain of the Spanish plunderer is solely owing to the lavish hand with which she has been endowed by nature with resources really inexhaustible and, as yet, practically untouched. It is to rectify these glaring imperfections in the political economy of his native land that the Cuban has taken down the old musket and refurbished the rusty sword, and it is for this that the mountain slopes and lovely vales of the paradise of the west are to-day echoing the din of battle and, let us hope, the shouts of Cuban victory.

It has been asserted, and maintained with some degree of pertinacity, by Spanish organs that the spirit of the present revolution in Cuba is a dark one ; in other words, that it is a race war, based upon racial enmity between the colored population and their Spanish governors, and that the success of the Cuban arms will mean the accession to power of the colored element upon the island. It is also pretended that the white population of Cuba are eminently contented with the Spanish *régime*, and are willing to again trust to a repetition by Martinez Campos of the promises which he made in 1878. Nothing of the kind. The white population of Cuba are sufficiently intelligent to appreciate the value of such promises, and will rely upon them no more. Aided by their patriotic colored brethren, the inhabitants as a whole, white and black together, are making the present fight, and the statement that this is a struggle between the white and colored races is as false as it is base. The colored population, upon the one hand, number only about four hundred thousand, and of this number hardly more than one third can read and write. Upon the other hand, there are, at least, twelve hundred thousand white inhabitants, all of whom are as intelligent and as well educated as the average citizen of the United States. To talk, in view of these figures, of an eventual colored government for Cuba is simply absurd ; so that we shall say but little more about it. It is sufficient for us to know that in the heart of our colored brother there is the same spirit of patriotism which animates our own, and both of us can contemplate with affectionate pride such a noble example of heroic devotion to liberty as was presented by Plácido, whose country was the idol at whose altar he sacrificed his life. In proof of the falsity of the allegation that race prejudice is the chief element in the present struggle, it is only necessary to advert to the fact that there are under arms in Cuba at least twelve thousand white rebels. If there are as many colored patriots fighting for independence, it is probably owing to the fact that the revolution began in a province where the colored population was much greater than the white, and it is this very circumstance which has been seized upon by the enemies of Cuba to lend color to the lie that the fight is one of race, and not the expression of the healthy sentiment of the majority of native Cubans. Indeed, some of the most distinguished—I was about to write aristocratic—white families of the island have sent members to represent them in the rebel camp. The Marquis of Santa Lucia, a venerable patriot belonging to one of the very first families of Cuba, is actually in the field ; Bartolome Masso, an eminent white Cuban of large wealth, is a general in the insurgent army ; Rafael Portuondo, a well known and able lawyer, and a member of a first-class family of Santiago de Cuba and Gen. Juan B. Zayas, son of a great Cuban scholar, are fighting in the ranks of the patriots ; Francisco Sanchez Echevarria, who belongs to the cream of Cuban society, a man of wealth and great social attainments, has just successfully landed on Cuban soil an expedition with a large quantity of ammunition for the insurgents ; and he has with him Señor Miguel Varona, a son of the greatest living Cuban philosopher. All these gentlemen, and many others high in the social scale of Cuba (which, by the way, is very delicately adjusted), most of whom have been educated in the United States, are heart and soul in active sympathy with the revolutionists, and are actually jeopardizing their own lives and fortunes in defence of their country's honor.

If this were a race war, those gentlemen would never be found within its ranks, nor would it receive the sanction and support of such men as Estrada Palma, Ponce de Leon, Francisco Sellén, Juan Bellido de Luna, and a great many other eminent Cubans, who are truly representative of the best elements of the island in education, conservatism, and personal worth.

That the fight will be a bitter one there can be no doubt. As late as last January the Spanish prime minister, Sagasta, in a speech delivered in the cortes at Madrid, declared that Spain would lose her last man upon the battle field and would spend her last dollar before she would consent to grant autonomy to Cuba. In this respect the attitude of Spain is characteristic, not to say quixotically so. It is alleged that Cuba is a continual source of outlay to the Spanish government. Perhaps so. It certainly is in anxiety and in blood, and the sooner the Spanish purse is exhausted, the better it will be for Spain, the better for Cuba, and the better for the entire western hemisphere.

But why is it that Cuba, so rich in her own resources, should prove a burden rather than a valuable possession of the Castilian crown? The answer is simple. Spain, instead of permitting able natives of Cuba to participate in the administration of the affairs of the island, sends over a horde of office-seeking, indolent, and insolent Spaniards, who are ignorant of the island, of its advantages, and of its requirements,—a band of men who have no affection for the country, or family-ties to unite them to the land, and whose sole object is personal aggrandizement within the shortest possible space of time. These people, in fact, take the revenues, and regard their offices merely as so many instruments by the use of which they can "bleed" the Cuban to their own advantage. In a word, the reason that Spain derives so comparatively small a revenue from Cuba is that Spanish employees steal. Cuba is certainly not to blame for Spanish theft.

Upon what ground of logic Spain can defend her possession of other people's property we know not; but certain it is that the exercise by Spain of dominion over Cuba has paralyzed the wonderful opportunities which that country would otherwise present to the enterprise of a free people, and, by exclusion, it has deprived the United States and the other countries of this continent of business amounting perhaps to millions. The Spanish government has never favored enterprise between the native Cuban and the outside world. Foreign capitalists neglect Cuba, since there is no security there or guarantees upon which to rely for the safety of investments. Well-informed merchants know how high Spanish duties are upon all kinds of foreign merchandise, and especially upon the necessities of life, such as flour, and, if they have ever done business with Cuba, they will undoubtedly retain some unpleasant recollection of custom-house restrictions and espionage almost sufficient to cause them to look elsewhere for a market.

And now, of course, pending hostilities which may, like the late war, last a decade, if not longer, the business of the island with the outside world is dead, and the commerce of Cuba with the United States is necessarily stagnant and must remain so until tranquility is restored and the great pulse of commercial life begins to beat again with rhythmic regularity. In Cuba it is well known that the situation is a very serious one for Spain, and it is impossible to tell what changes a very short time may cause in the financial system of the government. Hence, until peace be reëstablished, the business world will not exchange with Cuba, and her markets must remain closed until a happier day.

Should Cuba succeed in shaking off the Spanish yoke and establishing a republic within her borders, the effect upon the commerce of this country with Cuba would be incalculable. The American people can hardly realize the marvellous wealth of Cuba. She has been favored by nature with gold and silver mines enough to enrich the earth. Mountains of manganese are awaiting the enterprising capitalist who will convert them into wealth. Her forests are stocked with rare and precious woods, and her soil is as bountiful as any other on the globe. And yet is Cuba poor. All these natural stores are unproductive and undeveloped, because of the timidity and distrust of the American capitalist. He dislikes—and who can blame him?—to exploit a country which is liable at any time to be shaken to its center by the guns of revolution. With reasonable security upon which to base his enterprise the American capitalist would safely enter Cuba and reap untold wealth from the great field which lies there undeveloped, ready to respond a thousand-fold to the magical touch of the genius of American industry. Such a condition can prevail only when the Spanish government does not exist in Cuba. When it is no longer a figure in the theatre of Cuban affairs, then will that country naturally turn to the United States as its next-door neighbor, and deal with her rather than with others.

Geographically, Cuba is a portion of the North American continent, and no more belongs to Spain, except by the power of the bayonet, than does Florida. To whom, then, if not to the United States, would the marts of Cuba be opened upon a profitable basis to both parties? With the mind's eye we may stand upon the Cuban shore and gaze upon the commerce of all the Gulf of Mexico, we may trace the barks laden with merchandise upon the Mississippi river, and we may even, in fancy, cast our glance across the Isthmus of Panama and view the busy world that animates the Pacific slope upon the other side. Thus situated, Cuba would necessarily become a favorite market for United States goods; and, reciprocally, the markets of the United

States would receive the attention of the Cuban merchants and manufacturers. Indeed, for the limited trade which, under existing political circumstances, Cuba has been able to effect, it may be said that she is already commercially annexed to the United States, which have ever been her model in her struggle for commercial prosperity as well as for political freedom and self-government.

Whether Cuban independence would lead to the annexation of the island to the United States is a rather difficult problem; but it is certain that, once severed from Spanish thraldom, the island would never again be controlled by any European power. It is likely that the Cubans would, at first, endeavor to establish a republic, as they feel themselves entirely capable of self-government.

The prosperous condition of such towns as Key West, Tampa, and Ybor City, in Florida, which are exclusively Cuban colonies, shows what, under favorable political conditions, Cubans can do in the way of self-government and material prosperity and advancement.

Besides they possess a sentimental and national fondness for their beautiful language, which would cause a large portion of the population to desire that the country should remain as a distinct nation, fearful lest, by becoming an integral part of the United States, they and their language might become absorbed and finally disappear altogether in the great country to which they would be wedded.

But this is, at best, only a minor consideration. With or without annexation, a close intimacy must exist between the two countries, and, while the loss of the Cuban language would be less rapid in one case than in the other, still, if the fear of absorption be well grounded, such will be its fate in either event.

If the arrogant assertion of Spain that the Cubans are unqualified to administer their own affairs be true, they would naturally look to the United States and ask this country to open its arms and receive them into the Union. This, however, seems to be a remote probability, as the Cuban people are generally as well educated as the average American, and are, at the same time, much better adapted to govern themselves than the Spanish government is to govern them. Indeed, the spectacle of the Spanish government itself to-day is far from satisfactory.

It is obvious that annexation would be of great commercial benefit to both countries. The international barriers to commercial intercourse would be removed, and the same facilities would exist between the United States and Cuba as now prevail between New York and New Jersey. The demands of commerce would be met by the construction of railroads and bridges, giving employment to thousands of artisans in all departments of industry. It should be remembered, too, that Cuba is the greatest sugar-producing country in the world, and the development of this branch of trade alone would offer a large field for the introduction of American machinery, which has already, in the few plantations where it is employed, given results of a most satisfactory character. With Cuba free, an astounding impetus would be given to its commercial activities; engineering, in all its branches, would be called into active employment upon the island; agriculture, with its improved and labor-saving implements, would stimulate the rich and luxurious soil to the production of its choicest treasures; roads would be laid and aqueducts built; and the people, joyous in the sunshine of that freedom for which they are so bravely struggling, would turn their attention to the construction of homes, thus giving employment to architects.

The climate of Cuba would attract to the island thousands of Americans, especially in the winter season, and this increased traffic would necessitate the construction of first-class modern steamers to ply between the ports of the United States and those of Cuba.

These results would necessarily flow from the liberation of Cuba from Spanish dominion, even if it were not followed by annexation. The proximity of Cuba to this country would naturally produce that communion of interest which would lead inevitably to closer commercial relations between the two countries, and such fellowship would bring in its train a large measure of mutual prosperity.

It is for all these reasons, sentimental as well as practical, that the torch of revolution has been lighted in Cuba, and it is safe to say that, whether successful or not on this occasion, the people of Cuba will continue the struggle until victory perches upon their banner, and not a trace of Spanish rule, save the graves of Spanish soldiers, remains to remind her of her 400 years of intolerable bondage, wretchedness, and ruin.

To this end our people shall ever cry:

> "A las armas, compañeros!
> Viva el sable y el fusil!"

THE CANADIAN LUMBER INDUSTRY.

By J. S. Robertson.

THERE was a time when, to quote the language of a certain class of Englishmen, Canada was known as a "blawsted wooden country." The imputation, though made in cynicism, had much evidence behind it, for in the early history of the country the forests of Canada extended in an almost unbroken stretch from the Atlantic ocean to the head of Lake Superior,—a distance ot 2000 miles.

The Dominion of Canada has an area of not less than 3,456,383 sq. miles; that is, it is 430,783 sq. miles larger than the United States, if Alaska be excepted, and almost as large as the whole continent of Europe, which has 3,756,002 sq. miles. This territory is divided into provinces as follows: Ontario, Quebec, Nova Scotia, New Brunswick, Prince Edward Island, Manitoba and the Northwest Territories, and British Columbia, all of which are rich (in some measure at least) in forest wealth. The total population of Canada, according to the census of 1891, is 4,833,239.

Next to agricultural pursuits, in which 56 per cent. of the population are engaged, lumber is the most important industry of the Dominion. There is an invested capital in the business of nearly $100,000,000, and an annual wage-list of over $30,000,000, with an output valued at almost $110,000,000. Of saw mills and wood-working establishments there are about 6000, giving employment during the season to not less than 15,000 men.

The value of forest products, calculated from the census returns of 1891, is given by Mr. Geo. Johnson, government statistician, as $80,071,415. For the fiscal year 1890–91 the imports of wood articles amounted to $3,132,516, while for the same period the exports were $27,207,547, leaving for consumption in Canada $55,996,384, or a value of $15.59 per head. The census returns show an aggregate of 2,045,073,072 cu. ft. as the total cut of the year. About 30 per cent. of this is exported, leaving 1,431,551,150 cu. ft. for the annual home consumption. This is equal to 296.2 cu. ft. per head of the population, the estimate of Mr. B. E. Fernow for the United States being 350 cu. ft. per head.

As each of the provinces of Canada has an individuality of its own, geographically and physically, so has each its own individuality as a lumber centre. Canada's reputation as a "wooden country" rests primarily on the fame of its white pine (*pinus strobus*) in the prov-

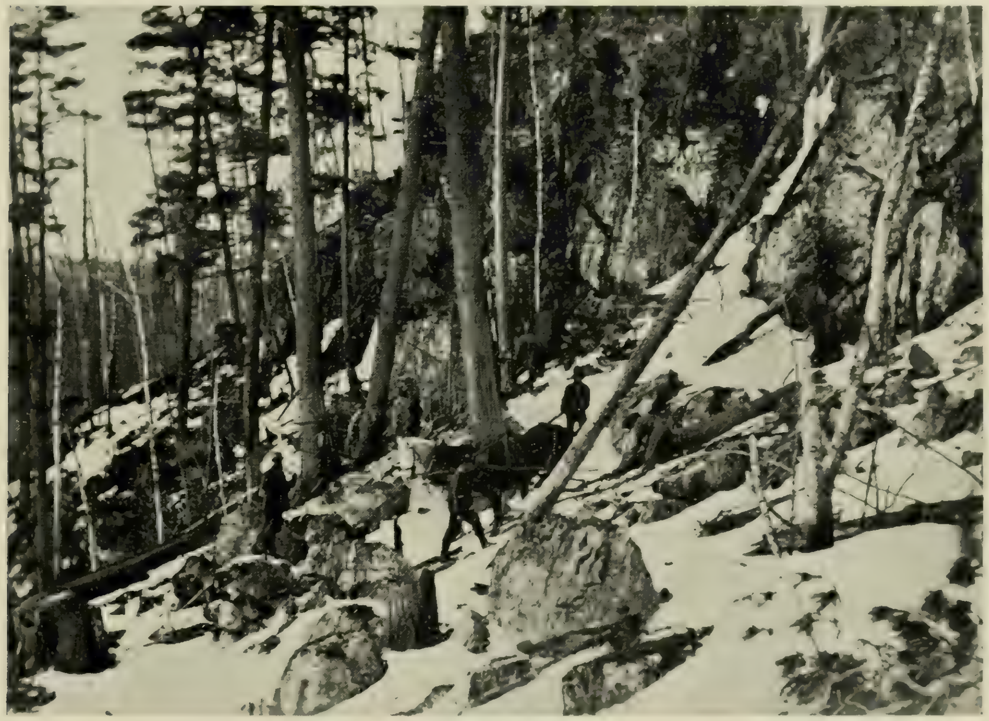
Cedar Tree 53 ft in circumference, Vancouver.
Forest Trees, English Bay, Vancouver.

Cutting in the Forest.
Squaring Timber.

Douglas Fir, 37½ ft. in circumference, Vancouver.
Spruce Tree, 44 ft. in circumference, Vancouver.

ince of Ontario. It is improbable that any one has learned anything of the lumber history of this country without having obtained a knowledge of the immense pine resources of the Ottawa valley and the Georgian bay districts. Ontario is spoken of as the great white-pine field of the Dominion, just as Michigan, Wisconsin, and Minnesota go into history as the great white-pine States of the American Union.

The ownership of Canadian forests is, for the most part, invested in the provincial governments, and in Ontario, in particular, the management thereof constitutes the most important department of government. The department of crown lands, which has the administration of the timber resources of the province, is the great money-making department of Ontario, and political opponents ofttimes inquire where the revenue of Ontario will come from when its forest products are exhausted? This department has been for many years under the control of Hon. A. S. Hardy, commissioner of crown lands, a gentleman whose name is frequently mentioned as the probable successor to the present premier, Sir Oliver Mowat.



IN THE FOREST ON THE OTTAWA RIVER.

The regulations respecting timber limits in Ontario are of importance to every one interested in this industry. Among other things they provide as follows:

That the commissioner of crown lands, before granting any license for new timber

HAULING LOGS IN THE FOREST.

berths (not including the lands) in the unsurveyed territory, shall, as far as practicable, cause the section of country where it is intended to allot such berths to be run into townships, and each township, when so surveyed, shall constitute a timber berth, but the commissioner may cause such townships to be subdivided into as many timber berths as he may think proper.

The berths or limits, when so surveyed and set off, and all new berths or limits in surveyed territory, shall be explored and valued, and then offered for sale by public auction at the upset price fixed by such valuation at such time and place, and on such conditions and by such officer, as the commissioner shall direct by public notice for that purpose, and shall be sold to the highest bidder for cash at the time of sale.

All lumber licenses are to expire on the 30th of April next after the date thereof, and all renewals are to be applied for and issued before the 1st of July following the expiration of the last preceding license, in default whereof the right to renewal shall cease and the berth or berths shall be treated as forfeited.

No renewal of any license shall be granted, unless or until the ground-rent and all costs of survey and all dues to the crown on timber, saw logs, or other lumber cut under and by virtue of any license other than the last preceding shall have been first paid.

All timber berths or limits shall be subject to an annual ground rent of $3 a square mile, payable only in advance before the issuing of any original license or renewal.

All timber, saw logs, wood, or other lumber cut under any license that may be hereafter granted shall be subject to the payment of the following crown dues: red- and white pine timber, per cu. ft., $0.02; red- and white-pine saw logs and boom timber, per standard of 200 ft. board measure, $0.20.

Operating under these regulations, which are closely enforced by the government, the cut of white-pine and Norway-pine lumber in Ontario amounts to about 700,000,000 ft. a year; taking the figures for the year ending June, 1893, the cut was 677,525,000 ft.

It is somewhat difficult to estimate the pine-timber area of Ontario. A return of the government of Ontario, brought down in 1893, says:

> No estimate has been made of the quantity of pine timber standing upon the whole crown domain. There is a great stretch of territory lying north of the 48th parallel of latitude and the northern limit of Ontario and between 85th west longitude and the easterly limit of the disputed territory, in respect of which no estimate has been made at all, containing 89,000 sq. miles or thereabouts, much of which, it is known, is pine bearing, but other portions are not, and as to some other parts there is no information. What has been done is to take certain areas known to be pine bearing and apply a reasonable estimate to them as follows:

	Sq. Miles.
West of the Ottawa River and north-west of the limits sold in 1872 between 80 and 85 west longitude, and extending north to the 48th parallel of latitude..................................	24,000
Between Ottawa Agency and sale of 1881 in the Nipissing District..........................	410
	24,410

	Ft.
To this area an average of 1,000,000 ft. B. M. to the mile was applied...	24,410,000,000
Col. Dennis, late deputy minister of the interior, estimated the timber in the disputed territory at.........................	26,000,000,000
	50,410,000,000
There is now subject to license in Ontario about 20,000 sq. miles, which has been estimated to contain 500,000 ft. to the mile, equalling...	10,000,000,000

> This gives a total on the territory estimated of 60,410,000,000 ft., exclusive of the territory of which no attempt at an estimate has been made as above stated.

Value.

The bonus value of 50,410,000,000 ft. at $1.50 a thousand equals...	$ 75,615,000
The dues upon this at $1 a thousand	50,410,000
	$126,025,000
Add for duty on 10,000,000,000 ft., estimated on licensed lands at $1 a thousand...	10,000,000
Making a total of...	$136,025,000

White pine limits in Ontario, though scattered through many hands, are largely held by the big lumbermen of the province, and of late years a very considerable part has gone into the possession of United States lumbermen.

LOG JAM ON THE NASHWAAK RIVER, N. B.

Mr. J. R. Booth, of Ottawa, has obtained fame as the largest lumberman in the world. He is an extensive owner of timber limits, and until a little more than a year ago operated what was generally conceded to be the largest saw mill in the world. This was destroyed by fire some 12 months since. Messrs. Gilmour & Co., of Trenton, hold a very prominent position as owners of timber-limits, as well as saw millers. At the government sale of limits, 2 years ago, this firm was a heavy purchaser, paying the largest price for a timber limit ever

SLUICE GATES ON THE NASHWAAK RIVER, N. B.

DRAWING AND PILING LOGS ON THE ICE.

known in Ontario. Among other large owners may be named: The Bronson & Weston Co., of which Hon. E. H. Bronson, a member of the Ontario government, is principal; W. C. Edwards & Co., Buell, Hurdman & Co., Robert Thomson & Co., The Georgian Bay Lumber Co., and The Muskoka Mill and Lumber Co.

When, 3 years ago, the duty on lumber going into the United States was reduced from $2 a thousand to $1 a thousand, a great

LUMBER READY FOR SHIPMENT.

HON. A. S. HARDY.

stimulus was given to the lumber industry, and there followed one of the best years that Canadian lumbermen had enjoyed for a long time. But this reduction in the duty on sawn lumber carried with it the free export of lumber in the logs into the United States, and this immediately built up an immense business in the shipment of logs by raft from the Georgian bay shores to those of Michigan. These shipments have grown, until in the last year something like 400,000,000 ft. of logs were exported from the Georgian bay shores to Michigan mills.

When the Wilson tariff became a law, conditions again changed, and the Ontario holdings of United States lumbermen increased. To-day a large extent of the timber limits of Ontario is in the hands of J. W. Howry & Sons, J. T. Hurst, Albert Pack, A. T. Bliss, General Alger, Saginaw Salt and Lumber Co., and other well-known Michigan lumbermen.

To what extent the change in the lumber tariff will induce American holders of Canadian limits to build mills in Canada is a moot question. All lumber being free, it is as easy to ship the sawn lumber as that in the log, and, this being the case, it is contended that United States lumbermen will find it an advantage to own mills near the limits, cut their logs there, and ship the lumber to their own country. It is known that J.

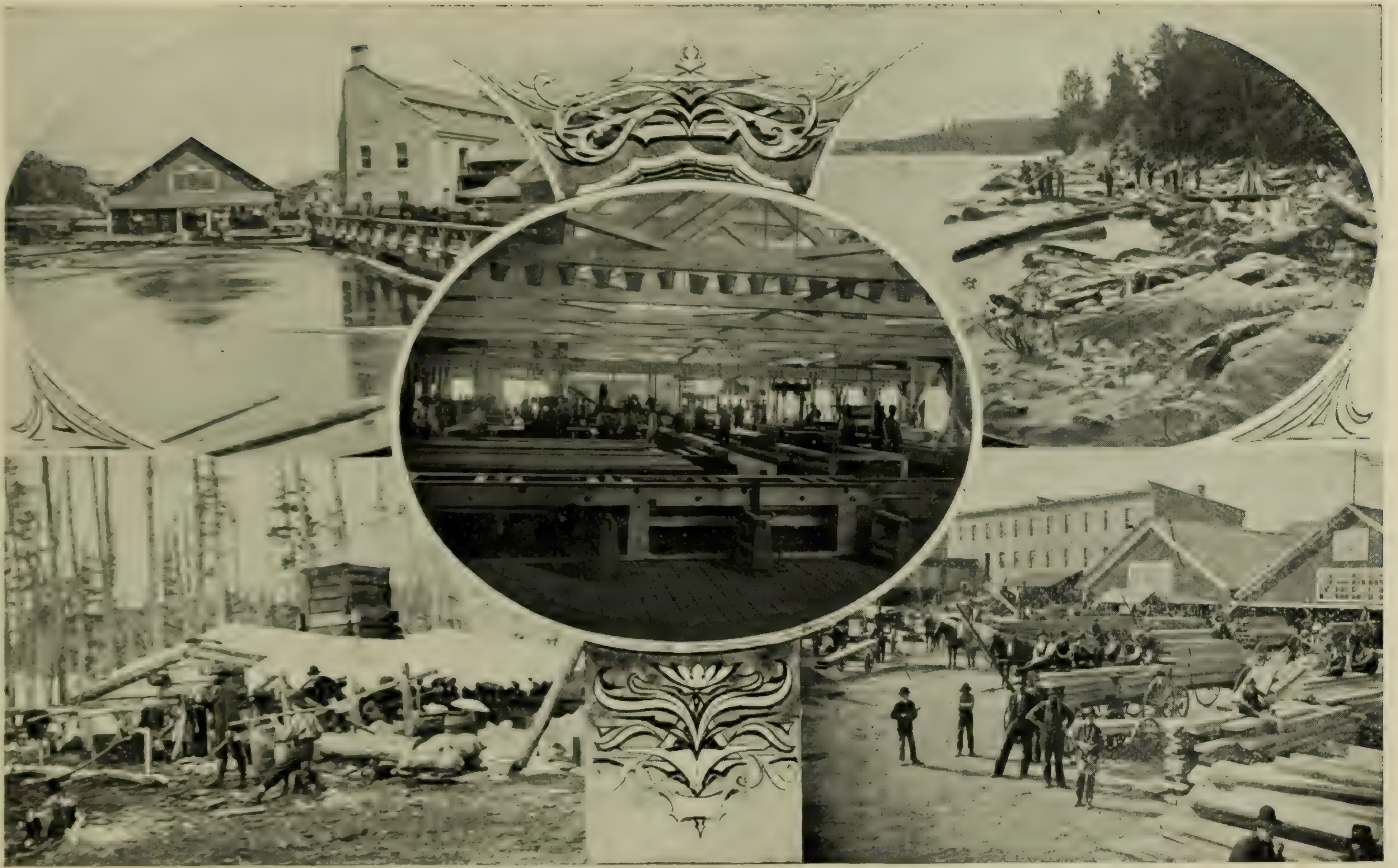
HON. E. H. BRONSON.

W. Howry & Sons, who will this season rank among the largest operators in Ontario, have erected, or come into possession of, large saw mills in the province. At Midland a large mill is cutting entirely for an American concern, and along the Arnprior, Ottawa and Parry Sound Railway, 140 miles from Ottawa, the St. Anthony Lumber Co., owned by E. C. Whitney, of Minneapolis, and other American lumbermen, has built one of the largest mills on the continent.

GEN. R. A. ALGER OF MICHIGAN.

There are problems in connection with the Wilson tariff that may change the complexion of affairs. A change in government in the United States might lead to a reversion of free lumber, though the manner in which investments are being made in Canadian limits by United States lumbermen, who ought to understand the situation, does not give much force to this theory. Again, the question has been raised, only within the present season, whether dressed lumber, which is exempt from duty, includes flooring and other lumber that is matched and grooved. The board of general appraisers of the United States has ruled against this rendering, and, if the ruling is sustained, it will be a barrier to the establishment of planing mills in Canada. But, on the whole, there is reason to believe that free lumber has come to stay, and that it will, aside from an exception or two, operate in the interests both of Canadian lumbermen and of their congeners in the United States.

While white pine holds the lead among the woods grown in Ontario, there are other timbers possessing good commercial value. Some years ago Ontario was rich in many of the most useful hardwoods; there was hardly a county in the province that did not contain a good supply of maple, elm, ash, beech, and birch. But to day these woods, though fairly abundant, are to be found only in small quantities. The extent to which the forests have been depleted of some of the most valuable hardwoods gives to advocates of forest protection a most forcible text. The late clerk of forestry for the province of Ontario, Mr. R. W. Phipps, has pointed out, in way of illustration, that in Kent



E. B. Eddy's Mill. Interior of W. E. Edwards' Mill, Rockland. Driving Saw Logs, Gatineau River.

Lumbermen's Camp. At Work in a Lumber Yard.

LOADING LUMBER AT J. B. BROOK'S DOCK.

county oak that sold 15 and 20 years ago at $4 50 per thousand feet could now be marketed at $25 per thousand, and walnut, which then brought only $14 per thousand feet, would to day command $100.

Crossing the border line to the older province of Quebec, we are brought face to face with lumber conditions of a different character. The chief lumber riches of Quebec, as also those of New Brunswick, consist of spruce. And whereas Ontario finds its principal and natural market for its forest products in the United States, Quebec's shipments are chiefly to Great Britain. There are several large concerns that look solely to the United Kingdom for their market. The area under license in Quebec, according to the statement of Hon. J. K. Ward, one of the oldest and most intelligent lumbermen of the province, is 48,000 miles, producing of spruce and pine logs 6,170,000 ft., equalling 683,000,000 ft. B. M.; of pine, spruce, and birch timber, 18,500,000 ft. B. M.; of railroad ties and other wood, 22,500 pieces, 12,000,000 ft. B. M.; pulp cedar, etc., 10,000 cords; revenue, $892,000. In New Brunswick the area under license is 6000 miles, producing, of pine and spruce logs, 87,000,000 ft. B. M.; of hemlock logs, 7,000,000 ft. B. M.; of cedar, 14,000,000 B. M.; of tamarac, 1,400,000 ft. B. M.; of pine and hardwood timber, 176,400 ft. B. M.; of boom sticks, 240,000 ft. B. M.; revenue and bonus, $102,000.

It is only within a few years that the spruce forests of Quebec, New Brunswick, and Nova Scotia have come to be appreciated at their real commercial worth, through the rapid development of the pulp-wood industry. It is conceded by some of the shrewdest manufacturers of pulp, not only in Canada, but in the United States, that these provinces have wonderfully rich resources in spruce, and this is in evidence in the fact that within a twelve-month large tracts of spruce land in Quebec, New Brunswick, and Nova Scotia have passed into the hands of syndicates composed largely of United States capitalists. Proof in the same direction is shown in the yearly increase of American importations. Exportation to the United States was inaugurated only 4 years ago. The figures are: $57,197 in 1890, $170,636 in 1891, $183,312 in 1892, and $454,253 in 1893, with a continued increase in 1894.

TRACTION ENGINE HAULING LOGS TO STREAM.

The reforestration of pine lands is a matter of many years, but experts testify that the young spruce will reach maturity in from 10 to 15 years. It will thus be seen that the owners of extensive spruce limits have within their possession an almost perpetual source of income. Pulp-making in Canada has within 10 years grown into an industry having nearly $3,000,000 of invested capital and over $1,000,000 of annual output. The lumber trade in New Brunswick has taken on new strength this year through the

J. B. BROOK'S MILL.

market found in the United States since lumber was placed on the free list.*

While the tall pines of Ontario have won the admiration of everyone who has made a study of the world's forests, yet to British Columbia belong the trees most admired both in the lumber trade and out of it. The giant cedars of California, whose story has been frequently told with pen and pencil, find their counterpart in British Columbia. There grow cedars of wonderful size and beauty. The red cedar of British Columbia is one of its most valuable timbers. With the forests of Ontario becoming all too rapidly denuded, it is proper to speak of British Columbia to-day as the timber province of Canada. The forest area of British Columbia is 285,000 sq. miles, or 182,400,000 acres. Its density is as remarkable as its extent. It is on record that on one acre in the Comox district 508,000 ft. were found. This is, of course, exceptional, but the average is 75,000 ft.

DINING ON A RAFT.

Commercially the most valuable of British Columbia woods is Douglas fir, named after a noted botanist of that name. It is found generously distributed along the coast. Because of its immense length, strength, and straightness, for many commercial purposes it has no competitor. Some of these trees grow to a height of 300 ft., and

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* Among the big lumbermen of New Brunswick are Hon. J. B. Snowball, Alex. Gibson, Malcolm Mackay, Geo. McKean, and E. Hutchinson.

SHIPPING LUMBER.

have a base circumference of 50 ft. The average height, however, is 150 ft., clear of limbs, and the average diameter 5 to 6 ft. Professor Macoun thinks that it will prove a valuable paper-making tree.

The red cedar (*Thuya Gigantæ*), of whose beauty I have already spoken, is very little behind Douglas fir in the race for commercial supremacy. For general purposes red cedar is doubtless the most valuable wood on the Pacific coast. Sometimes it reaches a height of 200 ft. and a diameter of 20 ft. The settler, when building his rude hut, finds a good friend in red cedar, while there are few woods that have been found more useful or beautiful for interior finishings in the finest residences.

But the woods of British Columbia are by no means confined to Douglas fir and red cedar. Species of spruce, hemlock, cotton wood, balsam, and even white pine, are to be found on the Pacific coast.

Saw-mill building owes its development in British Columbia largely to the past decade. There are about sixty saw mills in the province at the present time, with a daily capacity of over 3,000,000 ft. The cut of the province last year was 65,000,000 ft. The capital invested in these saw mills has been drawn largely from Ontario, some of the big mills being owned in the main by Ontario lumbermen. Ottawa lumbermen, too, have a considerable interest in the saw mills of the Pacific coat. The question is sometimes asked:

what is the possible longevity of the timber resources of British Columbia? One estimate, of a semi-official character, says that there are over 100,000,000,000 ft. of good timber in sight, and that, with the present saw mills making an average output, it would take between 150 and 200 years to exhaust the present supply. Another authority, however, estimates that it would last only 60 years.

British Columbia finds its main market for lumber in Great Britain, Australia, South Africa, South America, and other foreign points, with a new and growing market in California since the duty on lumber was lifted. The domestic market consists of its own province, with a good consumption in Manitoba and the Northwest Territories, while the red-cedar shingles of British Columbia have made their way in considerable quantities into eastern Canada, and have come into competition in certain sections of the United States with the Puget Sound cedar shingle, which is almost the same article. Mr. J. R. Anderson, provincial statistician, is authority for the statement that the yearly extent of lumber leases in British Columbia is 524,573 acres. The control of the timber resources of this province is mainly in the hands of the local government.

The province of Manitoba has little fame as a lumber district. Its great reputation is for grain, especially its hard wheats. There is a considerable saw mill and wood-working industry in this province, the supply of timber being drawn largely from the adjoining Lake of the Woods district, where timber is found in such abundance that United States lumbermen have their eye upon it. A considerable amount of lumber comes into Manitoba from Minnesota.

LUMBER YARDS, OTTAWA.

The growing uses of wood are so many and various that one can easily appreciate the remark of Mr. Atkinson in an article in the *Forum*: "The nations or States in which food, fuel, metal, and timber may be produced at the highest relative rates of wages and at the lowest money-cost per unit of product will thereby be enabled to apply labor-saving machines to other branches of productive industry in the most effective manner." Canada is rich in food products, for it is preëminently an agricultural country; in metal, it possesses an aggregation of riches that its people know little of; and fuel, whether wood or coal, is found in the Dominion in the greatest abundance. The figures which I have given leave no doubt of the extent of Canada's timber resources. In all particulars the requirements of Mr. Atkinson are fully met, and it is with a liberal measure of national pride that a citizen of Canada may refer to these matters, though recognizing at the same time that the cosmopolitan spirit of commerce lays open these vast riches to the entire world. Whosoever will may come.

RAFT OF TIMBER ON OTTAWA RIVER.

ARCHITECTURAL STUDENTS' WORK ABROAD.

By R. Phené Spiers.

IF, on the one hand, the multifarious duties which an architect is called upon to perform in the pursuit of his professional career involve an extensive range of study, there is, on the other hand, at least the element of variety in them ; no one has ever conceived the idea that monotony enters into their sphere. It is precisely this variety which gives zest to an architect's life, and at no period of his career does it come in better stead than when travelling through Europe in the pursuit of general knowledge. The problem of opportunities for architectural students' work is probably best solved when face to face with the querist in search of advice, for then the special idiosyncracy of the student, his power of work, the particular course of study he is anxious to pursue, and the weak points in his elementary studies suggest the line of advice which should be given.

In the absence of any such direct intercourse, it is possible only to suggest the various opportunities which may arise, leaving it to the reader to select those which appeal most to his particular quest. Take, for instance, the cases of the late Mr. William Burges and the late Mr. George Edmund Street, who elected to pursue a particular phase of style. It would be difficult to find a wider divergence of methods than in those which they employed in order to make themselves acquainted with the forms and the spirit of the Gothic style. The former, being very short-sighted, confined his studies almost entirely to measured work, to the most careful analysis and dissection, so to speak, of portions of buildings, in some cases of considerable size, all of which he measured and plotted on the spot. He attached the very greatest importance to this last consideration, and it is necessary only to look through his valuable book on "Architectural Drawing" in order to recognize the immense value of such a course of study. The flèche of Amiens cathedral and the choir of Beauvais constitute the most valuable record it is possible to lay before any student ; and, although it could scarcely be expected that many would have the courage to undertake so serious a task, these, though of little interest as show drawings, may be taken as models of the class of work which gave Mr. Burges the most intricate knowledge ot the methods of framing timber in the one case and, in the other, of the execution of the most splendid masonry construction possessed by the carpenter and mason of the middle ages in France. Mr. Street, on the other hand, was the most prolific sketcher of the age ; his custom was first to pace and lay down the plan of the cathedral or church, by practice, in which he became able to grasp all the essential features at a glance; then to make a perspective sketch of the choir seen from the other side of the transept, of two bays of the nave, and of such external features as attracted his attention, in all cases with the profile of the mouldings; and these, with a few ornamental details, enabled him to store his memory with the ever varying phases of design. When at Mont St. Michel in Normandy in 1880, he told the writer of this article that he had paced and worked out the plan and drawn the choir of almost every important church in Europe, and that his reason for visiting Mont St. Michel a second time was that on his first visit, when it was utilized as a prison, he had been unable to get inside the church.

Mr. Street used a note-book of hot-pressed paper measuring 8″ × 6½″, and he frequently drew across the two pages, giving him a surface of 13″ × 8″. His sketches, though most carefully made, were not show drawings, and his lines were rarely drawn through; it was sufficient for him to show the leading features, such as the arches of the orders with the profiles at apex and springing the shaft capitals and the leading vertical lines, leaving all other lines to the imagination. His perspective sketches of some of the Normandy towers were so accurately drawn and with such detail of features that they virtually gave more information than a ¼″ scale elevation. Curiously enough, he never used india rubber; this, however, necessitated much greater care in the setting-out, and, as he scorned the use of the T or set squares when out for his holiday, it involved a greater precision in the drawing of horizontal, slope, or vertical lines.

The writer has lately had an opportunity of examining carefully the sketch-book of the late Mr. Wm. Eden Nesfield, who apparently never used india rubber. He occasionally ruled in a few vertical and horizontal lines, and turned in some of the curves of the arches even when in perspective,—very lightly, however, and only as guides for the remainder; these he does not seem to have thought it necessary to rub out, for they can be traced at intervals under the bold free hand curve quite as accurately as those turned in with the bow pencil. Nesfield used to be credited with having a *camera lucida* in his eye, for so completely did he grasp his subject, and so impressed had it become on his retina, that, though he were to leave the upper portion of his drawing and indicate some feature temporarily exposed in the lower part, the whole would come in right at the end. It may have been this gift which enabled him to devote his attention to that beauty of line which is so remarkable in his sketches.*

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* Nesfield's sketches have just been published by some members of the Royal Institute of British Architects, and are now in their library.

To return, however, to Mr. Street. He occasionally made the most careful measured drawings, one of the most remarkable being that of Giotto's campanile at Florence. This was probably measured during its restoration about 35 years ago, when the whole tower was surrounded with scaffolding, and here it might be pointed out that unforeseen occasions present themselves which should be taken advantage of at once, even although it may upset the periods fixed for visiting other towns. Mr. de Dartin, professor of architecture at the École Polytechnique, Paris, obtained permission to measure the principal Lombard churches in north Italy at the time when the Italian nation, having entered again into possession, seized the opportunity to restore them. Mr. de Dartin could only count on his vacations for his work ; so for 9 consecutive years he visited Italy and measured the buildings which are represented in his remarkable work, "L'Étude sur l'Architecture Lombarde et sur les Origines de l'Architecture Romano-Byzantine" (Paris, 1865–82). The steel plates of this splendid work were not only drawn, but engraved, by him.

Burges, it has been stated, never made perspective sketches ; he made up, however, for the deficiency by the most diligent study, not only of architectural work, but of the various accessories. He made a special study of the stained glass of the French cathedrals, and is reported to have been the greatest authority on the iconography therein set forth. One other instance of his study is worth noting. When in Pompeii, instead of making water-color drawings of the wall decoration or of general views, which would have been difficult, owing to his shortsightedness, he made notes of the principles to be observed in the decoration of the various houses, with indications of the actual colors. Thirty years later he was destined to turn these memoranda to good account, for, when he was consulted about the restoration of the chapel of Worcester College, Oxford, built in 1714, the substitution for which of a Gothic structure had been suggested by Sir Gilbert Scott, he recommended that it should be retained, but refitted and decorated in color, and here, particularly in the ante-chapel, he recalled his recollections of his former studies in Pompeii.

The various descriptions of drawing in pencil or colors which may be adopted when travelling are detailed in the writer's work on "Architectural Drawing," published in 1887, so that it is not necessary to enter into that subject.

The opportunity for architectural students' work during tours may be divided broadly into two classes : those which have for their object the cultivation of the mind generally, with a view of developing the artistic powers of design ; and those which are of a practical and utilitarian character, such as the study of the planning of public buildings, hospitals, etc., including their lighting, heating, and sanitation. As a rule, the English student confines himself to the first class, except in the case of the holder of the Godwin Bursary, a prize awarded by the Royal Institute of British Architects to encourage the study of practical architecture in countries outside the United Kingdom.

Although a systematic course of study is advisable more or less in both classes, it is specially necessary in the second; and perhaps the student may find his best incentive by assuming that he is required to draw up a report, or series of reports, on such subjects as hospitals and asylums, public libraries, polytechnic schools, railway stations, town halls, or the housing of the working classes, etc. In such cases plans are of the greatest importance, and those are not always easy to obtain, unless they happen to have been published in special works or in some of the professional journals, access to which can generally be obtained in the public libraries of the larger cities. It is, of course, important that, previous to starting on the journey, a special study should have been made of the class of building on which the student intends to report. In connection with such buildings heating, ventilation, and sanitation form very important factors, and should be included in the report.

It is, however, to the first class mentioned that by far the greater number of students devote themselves; and here so much depends upon the duration of the student's tour, the special course of study he may have in view, and, in some respects, his power of drawing, that it is difficult to lay down any exact rule. In England, within the last 30 years, it has come to be recognized, and it was always insisted by the late Mr. Burges, that "measuring and plotting on the spot" is one of the best means of acquiring a knowledge of ancient work. With all Gothic work it is imperatively necessary, and the same applies to the earlier phases of the Renaissance.

In Italian work there is so much repetition, and the proportions of the orders as adopted by the architects of the Italian revival have been published in so many works, that actual measurement perhaps may be dispensed with. As a rule, however, the publications referred to are not always reliable; they are frequently very inferior representations of the actual building, and in no case do they give any clue to the real construction; so that the student will derive benefit by adopting a similar course to that necessary for Gothic work,—*viz.*, measuring and plotting on the spot.

Except in buildings of small size, there is always some expense involved in measuring, and permission cannot always be obtained to fix ladders against a public building. In such cases photographs may be utilized; they represent the actual relative proportions, so that, by measuring the plan and portions of the elevation, the remainder can be worked out from the photograph. It should be done, however, at the time, and an attempt made to work out the various projections and the mouldings of the cornices. When the late Mr. Burges was about to compete for the completion of the façade of the cathedral at Florence, he paid a visit to that town to study the building, and made use of a large mounted photograph, which cost him 15 francs. After paying for it, to the consternation of the shop keeper he deliberately bent it in half, face outwards, to reduce its size, and eventually covered the margin of cardboard with sections of mouldings and other details. It was an exceptional act and done for a purpose, and there is no doubt that this photograph, with its margin covered with details, was of more value for reference than if he had filled his sketch-book.

Sometimes a small photograph will serve the purpose, and, if pasted in the corner of the note-book, with the drawings of mouldings and details filling up the page, it will have more real value than in the portfolio, with the drawings in a sketch-book. Perspective sketches of small portions of a building—detail of ornament and sections of mouldings—are sometimes better understood if a representation of the whole building, such as is given in a photograph, is appended. This, of course, assumes that the drawings are made for use, and not for show.

While the measured drawing gives the student a far greater knowledge of the actual construction than can otherwise be obtained, perspective drawings give the actual appearance ; both should be used, one as a complement of the other.

To what extent the perspective drawing should be finished is a matter which depends on the subject. A mere sketch may sometimes be sufficient. Mr. Street's system of indicating the mouldings, the leading lines, and the lines of joining is perhaps the most valuable ; but there are not many students who possess his knowledge, or the extraordinary grasp he was able to take at a glance of the constructional and decorative qualities in a building. This failing may be met by making a more careful drawing, in which the student should not fail to take advantage of the T and set squares, and, when possible, of the bow pencil. To attempt to draw even the leading lines of an early English or perpendicular building by hand alone may be good exercise, but it involves waste of time. Instruments were invented to facilitate one's work, and the artist will always know how to avoid the hardness of a drawing made by ruling in the leading lines. The late Mr. Joseph Nash, whose drawings of Elizabethan mansions are well known, utilized the T square, even when working with a brush and in body color.

This leads to the consideration of the use of color in drawings, which may be looked upon as serving two purposes: first, the more actual representation of the effect of a building, where such effect is obtained by the juxtaposition of different materials, as red brick and stone, or, again, when colored marbles form an essential part of the design; second, the training of the eye. To travel through Italy and Spain and content oneself with perspective drawings in pencil only would be to lose a considerable portion of the special advantages to be derived from the study of the buildings there, in which color is one of the principal elements. To neglect entirely to record the effect of color in architectural work would be a mistake. But, beyond that, water-color drawing from nature gives the student one of the few opportunities which an architect has of training his eye to a sense of color, to harmonies and to contrasts.

The working drawings in an office are colored to define the materials only, and the tints are selected to show these clearly, and not in a decorative sense; in fact, in many cases the more violent the colors and their contrast, the better is the drawing understood by the workman. The pochades which a student may make in the evening after a day's hard work are also of great value in training the eye. Even those who are not gifted with a sense of color may take refuge in sepia or other monochrome drawings, in which the interpretation of values in nature and the massing of architectural forms constitute a useful and interesting course of study. On the other hand, there is some danger in the fascination of water-color, which is apt to lead the student from the more serious purpose of his tour. This, of course, does not apply to the studies of painted decoration, such as is found in Pompeii and in the various churches of Italy, or to mosaic work on walls, pavements, and vaults, all of which are proper and legitimate, besides being valuable as a training to the eye and affording a variation from measuring or drawing in perspective.

THE FUTURE OF THE ELECTRIC TELEGRAPH.

By Patrick B. Delany.

THE future of the telegraph will depend largely on the telegraph of the future. The telegraph of the present is, in its main features, the telegraph of the past, and, if it is to continue without material change, it is an easy matter to figure out its future, upon the basis of so many feet of wire for each inhabitant.

We have now about 1,250,000 miles of wire to sixty-five million people; but the probabilities are that, when we reach Mr. Gladstone's four hundred million mark, there will not be as many miles of telegraph wire as there are at present.

It does not require much foresight to realize that the final destiny of the telegraph is to carry all correspondence of any urgency, and that the present method of hand working, with its slow speed and multiplicity of wires, will give place to automatic or machine transmission, high speed, and fewer wires.

At present, owing to the expense, the telegraph is used only in cases of urgency, commercial or social. If a despatch could be sent as cheaply as a letter, the mails would dwindle to a mere miniature of their present bulk. In the commercial aspect it is simply a question of time against cost. Where "time is money," the telegraph claims its tolls. But there are degrees of urgency below the extreme which demand quicker communication than that afforded by the railway train; and the telegraph of the future will recognize these degrees of urgency and provide for them. With the exception of the half-rate night messages, telegraph companies have never attempted to differentiate their facilities. Messages, as a general rule, have been forwarded in the order of filing. In a case of life or death no one can acquire, by offering double, or a hundred fold, the usual rate for a telegram, the right to insist on precedence. It is optional with the company to push the message ahead of comparatively unimportant traffic, or transmit it in its turn.

There are fast trains, and fast steamers at premium rates; fast freights, and extra-delivery letters; but, except in the case of the night message, a telegram is a telegram, and haste goes only by favor. Common sense surely points to a change in this way of carrying on telegraphy. The Morse key, relay, and sounder, with hand transmission, are, and will probably for a long time remain, indispensable for a certain class of business,—*i. e.*, broker messages, train orders, and other despatches requiring instantaneous transmission. No automatic system requiring preliminary composing or preparation of messages will ever meet the requirements of the exchanges, between which transactions involving great amounts are made in a few seconds.

Few people, even among those who use the telegraph freely in ordinary business, realize that in the stock exchanges of London and New York half a dozen of the leading speculators sit constantly during the session at the operator's elbow, exchanging messages in 10 seconds; and even the initiated must wonder at this feat when it is understood that these messages are re-transmitted by hand at each end of the Atlantic cable. The exchange business of the entire country is conducted on similar small margins of time, and for this work no telephone, automatic transmission, or any other conceivable method can compete with the key and sounder. A message can be sent by key, clicked off on the sounder, and written down letter by letter, ready for delivery in the time that would be required to *prepare* it for transmission by an automatic system, and even more quickly than it can be spoken through a telephone with any degree of certainty. The telephone's thin piping voice will never buy and sell stocks, or wheat, to any large extent, or despatch trains on any busy section. Speed, accuracy, and record are imperative requisites for such work.

This much being conceded to the Morse system, it may, on the other hand, be stated that to attempt to limit the use of electrical communication for all classes of work to hand transmission would be dense folly. As well might the city of New York insist upon supplying its citizens with water from hand pumps at Croton lake, each ward having a separate pipe and pumper, and each pipe having a capacity fifty times greater than the capacity of the pump. Every telegrapher knows that the limit of hand transmission has been reached, and that, while fast-sending tournaments have pushed up the record two or three words per minute during the last decade, the average speed of working has not increased during the last 20 years. Indeed, it is claimed by many that, owing to the smaller wages paid by the companies, telegraphy has gone backward, both as to speed and quality. The use of the type-writing machine in lieu of the pen, it is claimed, has been beneficial, especially for presswork, admitting code words and abbreviations which are written out in full by the type-writing operator. This, however, is of comparatively small importance. The operator has done his best.

It is pretty well settled that the telegraph companies cannot go on increasing the number of wires. They themselves admit that in future increase of facilities will have to come either through automatic working or through a further multiplication of circuits derivable from a single wire, and of the latter there is little hope.

The British post office recognized the inadequacy of hand telegraphy more than 20 years ago, and put in operation the Wheatstone machine system. Beginning with a speed of about fifty words per minute, the telegraph department, with praiseworthy persistence in the direction of higher speed, has gradually improved the system, until now it is carrying an enormous amount of traffic at speeds ranging from one hundred to four hundred words per minute, according to distance and the character of the conductor. The system is also worked duplex, but at speeds less than double the simplex speeds.

The Wheatstone system was introduced into this country about 10 years ago, and, although it has not been extended as rapidly as might have been expected, it is firmly established on several of the most important routes, notably from New York to Chicago. Over this circuit seventy-five words per minute duplexed, or one hundred and fifty words in all, are obtained. An automatic repeater is used at Buffalo, as through working is not practicable over the present wires.

Now, while the Wheatstone system is a great advance over the hand method for heavy traffic, it can never, in the nature of things, be the telegraph of the future,—that is, if the great bulk of correspondence is to be carried by telegraph. The main obstacle in the way is the electro-magnet of the receiver. The speed at which, with a given pressure, an electro-magnet can be made to move an armature through the required space, and with sufficient power to make ink marks on a tape, depends mainly on the sum of these hindrances,—resistance, electro static capacity, and self-induction. It is safe to assume that the British post office has not stopped short of the highest efficiency possible in dealing with these matters, and that the work of the Wheatstone system in England at present is not likely to be improved upon to any important degree. It must be plain, therefore, that, taking it at its best, this system falls far short of the speed necessary for rates sufficiently low to popularize the telegraph as a corresponding medium.

Giving the Morse and Wheatstone systems full credit, it is my opinion that the system for carrying the mass of correspondence now carried by mail will be one employing automatic transmission, and chemically-prepared paper for reception of signals,—a system having no electro-magnets, no armatures or movable parts, no springs or contacts to adjust, and no inertia to overcome, and one that is not thrown out of adjustment by slight changes of the circuit. The chemical plan of recording is based upon electrolysis. The saturated strip of paper forms a part of the circuit, and its sensitiveness for speed is at least twenty times greater than that of any electro-magnetic recorder.

Davy is credited with the discovery that the passage of an electric current through paper moistened with certain chemicals would leave a mark in the track of the scraping finger under which the paper ribbon was drawn. Alexander Bain was the first to use this discovery for recording telegraphic signals. His automatic system of about 40 years ago met with some success, but it had numerous defects, both mechanical and electrical. The perforating machine for preparing the message for transmission was crude, slow, and unreliable. "Tailing," or running together of the signals, making it difficult to separate the dots from the dashes, was the chief electrical difficulty.

During the past 25 years chemical telegraphy has at different times engaged the attention of numerous able inventors, and considerable progress has been made towards overcoming the difficulties in the way of complete success. Humaston, Grace, and Anderson applied much ingenuity to the development of perforating machines, while Edison, Little, and Anderson have done much in the direction of remedying the baneful effects of "capacity" and retardation, of which "tailing" and "clipping" of signals are the results, by the use of self-induction derived from electro-magnetic shunts and the use of condensers. By these means the speed of working with chemical telegraphy was almost doubled, but, even with these advances, there was still much to be desired.

Improvements of the perforating machine were to a large extent neutralized by more complicated mechanism and greatly increased cost of construction. Experience shows that, no matter how efficient such a machine may be in expert hands, it can never come into general use. For cheap telegraphy the perforating machine must be simple, reliable, and of low cost,—an instrument requiring no mechanical knowledge whatever, on the part of the operator, to keep it in working order at all times,—as simple, for instance, as the type-writing machine, the wonderful popularity of which is due mainly to this feature. In mechanics it seems to require but a very small draft on expertness to exceed the limit of popular ability.

Recent improvements in the perforating machine, transmitter, and receiving instrument for automatic chemical telegraphy have at last brought this ideal plan of rapid communication to a degree of perfection which cannot fail to bring about sweeping changes in transmission of correspondence in general. Between New York and Philadelphia over a copper wire weighing 300 lbs. to the mile three thousand words per minute can be recorded perfectly, and, with a copper wire weighing 850 lbs. to the mile, one thousand words per minute can be carried from New York to Chicago. It is between such large centres and over such long distances that the importance of such an achievement can be appreciated. The field for such a system lies between the present telegraph rate of, for example, 40 cents for ten words from New York to Chicago, and the letter by rail, occupying nearly 30 hours, for 2 cents. At a speed of one thousand words per minute over one wire, it is estimated that a fifty-word message can be perforated in New York, transmitted automatically, type-written, and dropped in the post office in Chicago at an actual labor cost of 3 cents, to which the cost of the stamp must be added. Two wires of the character named, worked to their highest capacity, would carry all the letters now exchanged between New York and Chicago, provided their average length is not more than fifty words, and all the messages handled by the telegraph companies as well.

The telegraph lines of the future will be in keeping with their importance as means of communication. Iron poles, set in cement foundations, like the best trolley lines, large copper wires, protected above and below by steel guard wires of great strength, and undisputed right of way over shortest routes will be the main characteristics of the mail-carrying lines. The guard wires will be used for way stations and test offices. The copper conductors will carry through-business by the fast system. When it is once proven practicable to deliver one thousand words per minute in plain Morse characters over a circuit 1000 miles in length, all prejudices hedging about old systems and methods of handling business should be swept aside. A perforator and a type-writer will in effect be a sending operator and a receiving operator, and about forty will be employed at each end of a single wire. Can it be doubted, then, that in the near future the telegraph will be the medium of general communication? Great changes have already taken place in the comparatively modern methods of correspondence. To realize this, it is not necssary to go back to the postboy on horseback, the packet boat, or the stage coach. As late as 20 years ago nearly every business man wrote his own letters, and very bad chirography jogged along by mail train at 20 miles an hour. Now, probably over 90 per cent. of the business letters are dictated to stenographers, and plain type-writer print speeds along at 40 miles an hour. The letter of the future will be dictated to a stenographer, who, instead of type-writing it, will perforate it on a paper tape. This tape will be sent to the telegraph office, where it will be put through the automatic transmitting machine, and in a second or two it will be at its destination. The receiving tape will be delivered direct, and the plain Morse characters will be translated on the type-writing machine by the correspondent's stenographer. Commercial houses having a large business will do their own perforating and translating, thus securing important reductions from the regular tolls. For them the telegraph company will be simply a carrier, having nothing to do with their correspondence but putting it through the machine. Nor will such messages be read by any of the companies' employees, any more than open letters are now read by postal clerks. This will practically render all such correspondence secret, as the perforated strip may be withdrawn as soon as it has been used. The contents will not be forced upon the notice of the telegraph operator as at present. Newspapers, railway companies, or other large corporations which now frequently have to resort to ciphers and codes to prevent "leakage" will welcome this privilege of protecting their secrets. A few weeks' practice is all that is necessary for learning to read the Morse characters with great facility from the paper tape, and proficiency on the perforating machine may be reached in the same time, so that to the already varied accomplishments of the type-writer will be added perforation and translation of telegraphic correspondence. Translation from Morse characters will be easier than from stenographic notes, with none of the elements of doubt attaching to the latter. This reference invites a digression. Is it not time that boards of education took under consideration the advisability of substituting the study of Morse alphabet and the use of the type-writing machine for some of the courses of doubtful utility now maintained in public schools? The language of dots and dashes is the only real volapük, the universal sign language, a knowledge of which would enable a deaf mute to make himself understood from Kansas to Khartoum wherever he found a telegraph operator. If, as it would seem, all commercial correspondence is to involve stenography, type-writing, and telegraphic characters, why limit instruction to penmanship?

Speculation as to the future of the electric telegraph would be within extremely narrow bounds if the question of government control was not considered. It may be somewhat remote, but it is hard to avoid the conclusion that the government will not always draw the line as to the vehicles to be employed for carrying its mail. It now uses over three thousand railway cars on 150,000 miles of road, and keeps six thousand clerks on the move, traveling in crews 140,000,000 miles a year, during which time nine billion pieces of mail matter are handled. About three hundred mail cars are wrecked, a dozen clerks killed, and one hundred and fifty injured during the same period. The total expense of the postal service is about $75,000,000 per annum, and the department is not far from than self-sustaining. How can so vast a system ignore the difference between railway and electrical speeds? A car travels 40 miles an hour, a current 200,000 miles a second. The automatic chemical telegraph will send a message of sixteen words from New York to Chicago every second, and fifty words—about the average of a business letter—in 3 seconds. If time be reckoned as the basis of value for correspondence, which will appeal most to the business man,—a letter occupying 24 hours in covering 1000 miles for

2 cents, or a telegram going the same distance in 3 seconds for 15 cents? Would not a very large proportion of business communications warrant the extra 13 cents? Could a man using the train mails compete in business with another using the the telegraph? Not any more than a man traveling by canal could rival another going by the limited express.

Neither the constitution or any act of congress places limit or restriction on the mode of mail-carrying. The giant proportions and rapidly-increasing power of telegraph interests of late years, coupled with the difficulties presented by the political aspect of the case, doubtless account for the fact that to-day the United States is the only country that does not control its telegraphs. Other governments took them over in comparative infancy, when it was an easy thing to do, and telegraphy has thus become engrafted into their general schemes of communication. The use of the telegraph in many countries of prominence is much more general than in America, notwithstanding the fact that nearly all the improvements—notably Hughes, Printer, the Duplex, Quadruplex, and Synchronous Multiplex systems in their practicality—came from America. The British post office, without prejudice or jealousy, took all these in their turn, and concurrently developed their own Wheatstone system, until to-day, for reliability, accuracy, and uniformity of time, its telegraph service is unequalled.

The British telegraph has not paid its way. It almost reached the maintenance point a few years ago, but the telephone inroads on its business became too great. The deficit is attributed mainly, however, to the enormous amount of press reports carried at very low rates. At night, the first charge of a shilling on a hundred-word message having been paid, the message may be duplicated as many times as desired to any part of the United Kingdom for 4 cents.

In foreign countries, as with ourselves, popular rates have not been available, owing to slow methods of operating; but, now that automatic working is supplanting the hand system, important changes may be looked for. Already Italy, having introduced the Wheatstone system, is about to try the experiment of 5 cent telegrams.

It seems inevitable that sooner or later in this country the government will use the telegraph, either in a monopolistic or a competitive way. It cannot go on restricting the postal service to hauling of actual paper by rail. Among other of its beneficent aims its mission is to place its people in communication by the quickest means at the lowest cost, and for this purpose the telegraph alone will answer. There can be no more striking example of the public desire for quick facilities of communication than is shown in the avidity with which they have taken advantage of the quick-delivery system instituted by the post office a few years ago. Every such letter is an evidence that the writer is willing to pay 10 cents in order to expedite the delivery of his letter half an hour. If these letters could be telegraphed for, say, 15 cents, or 3 cents more than the ordinary and extra postage, no one can doubt that nearly all would go that way.

Mr. Delany's strong presentation of the argument in favor of government ownership of the telegraph systems offers an excellent opportunity for the presentation of the other side of that important question. The following editorial from a recent issue of *The Journal of Commerce* of New York, speaks for itself.—THE EDITOR.

The post office department is the stock example of efficient government management invariably cited by persons who desire to enlarge the field of public and restrict the field of individual enterprise. The financial statement of the New York office, just issued, will assist one to understand how little the management of the postal service warrants a general extension of the functions of the government in the field of transportation, construction, and production.

The total receipts of the office in this city in the late fiscal year were $7,264,984, and the total expenses were $2,972,126, including nearly a million and a third for the free-delivery service ; this afforded to the government a net profit in operating the post office in this city of $4,282,857, or about four-sevenths of the gross receipts.

The first reflection suggested by these figures is that the profit was extortionate. No business open to competition can make anything approaching this rate of profit. If the government would withdraw from the field, or would at least waive its monopoly, private companies would render the service for half the present scale of charges, and would expedite the service and would assume responsibility for losses,—a thing the government will not assume, even when its customers pay a registration fee. So far as this city, and in fact this section of the country, goes, it is suffering from a monopoly which in private hands would not be tolerated for twenty-four hours. Repeated efforts have been made to evade the government monopoly and carry letters in this city at a one cent rate. Private companies would jump at the chance of collecting letters at people's houses and offices and delivering them for one-half the charge made by the government, but the government monopoly is securely guarded, and we must pay more than double what the service costs.

The government, however, makes no profit on its postal service. It carries letters and newspapers on the philanthropic principle on which the Populists desire it to carry wheat and corn and cotton. There are a few States in which the government makes a profit out of its post office. But in the great majority it does its postal business at a loss. The profit made in New York is used to fill the deficit in the postal business of many western and southern States; not every eastern State, even, shows a profit for the post office. The government exercises the right of charging vastly more than private carriers would for doing a postal business here, and of using the profit to enable it to do a postal business in Nebraska for very much less than any private carrier would,—for much less, in fact, than it costs to do it.

This is a process of equalization which doubtless meets the approval of many persons in the west and south who cannot imagine any reason why the east should not be taxed for their benefit, and who argue plausibly that the east makes money out of the other parts of the country, and should meet a good part of the expenses of carrying on the other parts. But the philanthropy of the post office does not stop here. It does not have to live on its income. It is in the happy position of the young man who earns what he can, but whose unpaid bills are annually settled by his indulgent father. For the current fiscal year the appropriation for the postal department is $89,545,997, made up of all the revenues of the department and whatever additional sum may be needed to meet expenses. This is estimated to be two and a half millions, but is quite likely to be more, for the appropriation is a million and a half less than the estimates of the department, which is very well informed as to its liabilities. The deficit is made good out of money raised by taxation. The postal service is conducted at less than cost to the people who use it, but the deficit must be made good from some quarter; it is made good out of other people's pockets, or out of the pockets of the people who use the post office, but at times when they do not know what they are paying for. A man gets a letter carried for one cent less than the cost; and then, for every five glasses of beer he drinks, the government takes a cent out of his pocket to make good the cent it lost in carrying the letter.

The political importance of rapid communication between all points in the country is sufficient to justify the government in carrying letters without profit, and even at some loss; the deficit will never become unmanageable. But, if it did a telegraphic service on a like plan, the aggregate deficit might become serious, for the postal deficit has been seven or eight millions. The fact that the government charges nothing for the service of carrying country papers within the county of publication in order to conciliate the "palladium of our liberties," though it has to pay for this as for any postal service, affords a glimpse of the dead-head service that would be exacted of the government by political influence, should the government extend its philanthropic operations to the telegraphic field, the railroad field, or the factory field. It is well known that much of the financial embarrassment of the Australian colonies is due to the fact that, to please this constituency or that, the colonial governments have extended the railroads, nearly all of which are public property, or reduced charges below the cost of rendering the service. There is now at large in this country a Californian named Lubin, who is trying to get people to demand that the government shall defray a part of the cost of shipping grain abroad. This cost cannot be eliminated, though the ordinary competition of trade has wonderfully reduced it. But whatever the government disburses on that account it must get from somewhere; it must raise by taxation. Probably the farmer is quite willing that the cost of exporting his grain shall be paid by some one else. But it is quite clear that every one cannot get his expenses shouldered off upon some one else. If those who dance do not pay the piper, the "wall flowers" must, and it is not likely that they will long consent to.

That the government does the postal service economically is a common assertion which will not bear any examination. In the populous east it charges a rate which yields profits that only the most avaricious and successful trusts ever dreamed of. No private company was ever robbed on its contracts as the government was in the days of "star route" frauds, and, though these days are over, no one familiar with the contract office of the post office department will pretend that the government gets this branch of mail-carrying done as cheaply as express companies would. Far the largest item in the cost of the postal service is the payment to the railroad companies, the rate governing which has not been reduced for seventeen years, though, for all other services rendered, the railroad companies are getting much less,—in fact, not much more than half. Monopolies as they are said to be, the railroad companies have reduced their passenger rates and their freight rates in the most radical fashion, while the government goes on paying the same rate per hundred pounds for carrying postal matter that it paid seventeen years ago; and it is paying to the large railroad companies, which carry the heavy mails, a rental for the use of postal cars which annually exceeds the cost of building the cars, and which is additional to the payment by weight.

Instead of justifying an extension of government activities in transportation and production, the facts of the postal service constitute a warning that the nation would be bankrupted in five years if the government undertook to carry on the freight business upon the principles which govern the carriage of the mails.

THE NEWHOUSE TUNNEL AT IDAHO SPRINGS.

By Arthur Lakes.

AMONG great tunnel enterprises the Nesquehoning, Musconetcong, Hoosac, and Sutro, in America, and the Mt. Cenis and St. Gothard, in Europe, are familiar. The Rothshönberger Stollen tunnel in Saxony is an example of old style and of German perseverance. Of these the Sutro and Rothshönberger Stollen are most akin in purpose to the one which is the main subject of this article.

In Storey county, Nevada, rise sa great mountain chain, the Washoe range, its peaks reaching 7800 ft. above sea line. Of these Mt. Davidson consists of syenite, and overlying the vein are augite and hornblende porphyries. The width of the lode is from 50 to 100 ft., and sometimes very much more. Even in the early and most prosperous days of the mine it was considered that it would be advantageous and necessary in a few years, for the continuance of mining, to tap the lode at a greater depth by tunnel. Before the tunnel the ore, refuse rock, and water were raised to the surface through the shafts by steam power, and the ore transferred to mills by wagon and rail.

In 1860 Mr. Adolph Sutro conceived the plan of driving a deep tunnel to the Comstock lode. In 1865 the legislature granted a franchise of right of way. The other mining companies working on the Comstock lode agreed to pay a toll of $2.00 per ton on every ton of pay ore after the completion of the tunnel.

Congress, by the "Sutro Tunnel Act," gave Mr. Sutro :

1. The right of way to run a tunnel 7 miles in length to and beyond the Comstock lode and a north and south drift on this vein and all others found on the line of the tunnel.

2. The right to sink shafts on the line of the tunnel, and to purchase public land in connection with the tunnel at $1.25 per acre.

3. The right of acquiring at $5 per acre all veins which occur inside a distance of 2000 ft. from the tunnel, except those already in possession of other parties.

4. To levy a royalty on mine owners, in consideration of the drainage and other advantages, on the completion of the tunnel.

Between 1860 and 1878 the Comstock produced $291,341,026. Its total product up to to-day is more than $325,000,000.

Mr. Sutro's scheme was to make the tunnel a main artery, from which branches should extend thoroughout the entire mining district,

NEWHOUSE TUNNEL, GENERAL VIEW.

which has a width of 8000 ft. and a length of 5 to 7 miles. This it was proposed to cross-cut at intervals, and re-cross cut, thus finding all bodies of ore in the district; also to supply cheap transportation, drainage, and other facilities.

The tunnel, starting from Carson valley, penetrates the rock 20,000 ft. and strikes the lode near the middle of its productive portion, 1900 ft. below its highest outcrop. The rocks encountered were hornblende-andesite, augite-andesite, diabase, and diorite.

The greatest depth reached by shaft was 3000 ft. Intense heat prevails in the lower levels, and much hot water is found there.

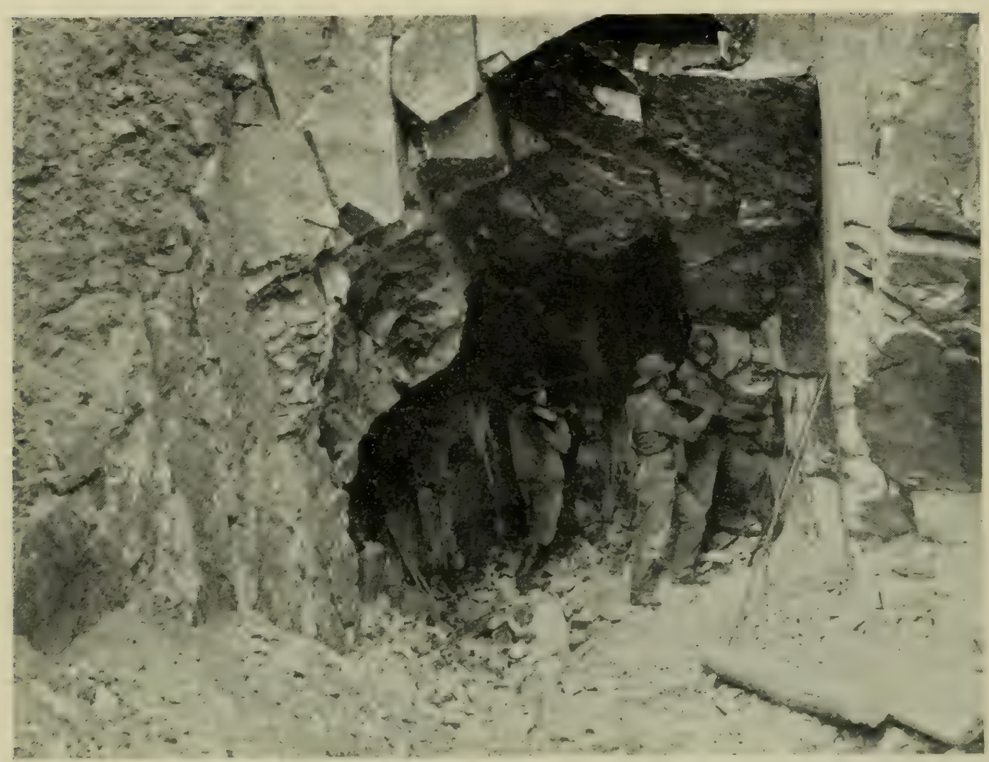
In July, 1878, connection was made with the Savage mine at 20,000 ft., and a strong draft set in at once. In September, 1878, another mining drift was encountered, and in October a third. In January, 1879, connection was made with four more shafts.

In September, 1872, the first attempt at machine drilling was made, and 542 ft. of holes drilled in 30 days by the Burleigh drill. Dynamite was first used in 1870. Six drills were used in the face.

The Sutro, as typical of the introduction of the new style and appliances, and the Rothshönberger Stollen, as typical of the old style, are worthy of comparison. The latter was commenced in Saxony in 1844 and opened in 1877. All but the last few hundred feet were driven by hand labor, without any of the modern appliances. The best average attained was 279 ft. per month. The length was 42,366 ft. The deepest point reached was 308 ft. below the surface. With all its branches completed there will be about 31 miles of tunnelling,—the longest tunnel in the world. The cost up to 1874 was $1,500,000, or about $51 per running meter.

This long tunnel gains a depth of only 308 ft. below the Anna mine adit, and connections with other mines give a drainage of only 499

IDAHO SPRINGS, LOOKING TOWARD TUNNEL.



STARTING THE TUNNEL. HAND DRILLING.

feet. The object of this tunnel is the same as that of the Sutro, which is 5 miles long and meets the workings nearly 2000 ft. below the surface. "If," says Mr. Devinter, "the economical Germans are willing to spend so much money and time in making an adit 30 miles long for the sake of gaining a depth of but 300 ft. of drainage, it is evident that the days of deep tunnels are not over."

In Utah they are running a tunnel 4 miles long to drain by a few hundred feet the celebrated Ontario silver mine, and this through the hardest of rocks, limestone, and quartzite. In Colorado, besides the Newhouse tunnel, many tunnel enterprises have been carried out, while others are in process. Notable among them is the Yak mining tunnel at Leadville, driven for "custom" and drainage purposes through Iron hill into Breece hill. The scheme was outlined by Mr. A. A. Blow, manager of the Silver Cord mine, in 1890. The tunnel opened into California Gulch, and in 1893 had been completed to the Silver Cord mine. This enabled the managers to handle a large quantity of low-grade ore from this mine, and treat it at the concentrating mill erected at the mouth of the tunnel. From the Silver Cord the company is pushing the tunnel on to pierce Breece hill and the celebrated Leadville gold belt of Ibex fame, and thus open up a number of gold properties by means of an underground route. The rocks passed through are quartzites, limestones, and porphyries.

With these examples before us, we may proceed to describe the Argo tunnel, or—as it is more commonly known, from the name of its enterprising projector, Mr. Samuel Newhouse—"the Newhouse tunnel," at Idaho Springs, Colorado.

Idaho Springs is a pretty little watering place, as well as mining town, 30 miles from Denver in the Front range of mountains. It is situated by the rapid stream of the South Fork of Clear creek, and is as well known as a health resort on account of its mineral and soda springs as it is for its wealth in gold and silver mines.

Central City, on the other hand, is essentially a mining town, situated high up among the mountains, about 4 miles north of Idaho Springs. It is built on the sides and ledges of the cliffs and hills above the North Fork of Clear creek, an insignificant stream affording but a very inadequate supply of water to the mills and mines of Central City, Nevadaville, and Blackhawk, while the South Fork is a powerful stream with an abundant water power the year through.

Between these two forks of Clear creek lie the mining areas of Central and Idaho Springs, which, from a mining point of view, may be regarded as practically one.

On the southern face of this region, ascending from Idaho Springs,

NEWHOUSE TUNNEL. HAND DRILLING.

DRILLING THE SIDE ROUND.

the surface is steep and mountainous, diversified by ravines and culminating on the summit of Mt. Pewabic several thousand feet above the river, from which point a fine view of both the Central City and Idaho Springs areas is to be had. From summit to base the mountain slope is dotted with mine openings and prospect holes, following certain roughly parallel lines indicating the outcrops of a series of parallel fissure veins. These veins the Newhouse tunnel expects to cut at considerable depths, at right angles to their general strike or direction. From the top of this mountain, forming the dividing ridge between the two mining districts, we look down in a northerly direction on a country of rolling hills and open valleys, which continues as far as the cañon of the North Folk, along whose banks string in a long connected line the mining towns of Nevadaville, Central, and Blackhawk,—towns whose streets and houses are undermined by many tunnels and shafts, while the noise of ore crushing mills but ill supplied with dirty water fills the air, indicating the mining activity of the vicinity. This part of the section (in Gilpin county) is even more honeycombed with mines and prospect holes and dotted with mining dumps and shaft houses than the Idaho Springs side, impressing us with the fact that the whole region is underlaid by a vast network of gold and silver veins, many of which have produced ore continuously for the past 30 years.

The geology of the entire region is simple. The rock is mainly mica-schist and gneiss of a granitic type. In the general uplifting and folding of these mountains a series of more or less parallel fissures were formed, extending for some miles across the country and descending to depths far below the reach of mining operations. These fissures were filled with quartz and feldspar veins, carrying also a certain percentage of gold and silver, principally the former. The experience of 30 years has shown in the deepest mines—such as the California, over 2200 ft. deep—that richness rather increases than diminishes with depth. Accompanying the uplifting were eruptions of molten porphyries through fissures now traversing the region as long dikes. These porphyries are the common accompaniments of our mineralized regions.

The great number of mineral veins in this region is shown by the section of those already well known and developed that lie in the path of the projected tunnel; also by the books of the United States surveyor general, who reports 1400 mineral claims patented in Gilpin county alone, with a large number on the Idaho Springs side. There is no doubt that, in addition to these, there are a great number of as yet undiscovered veins lying in the intervals between them, obscured on the surface by brush and *débris*. These "blind veins" will be discovered by the Newhouse tunnel in its deep workings, and will become its property. The development of these will add to the revenue of the tunnel. The Newhouse tunnel proposes to undermine at an average depth of nearly 2000 ft. a mountain of gneiss and schist 3¾ miles in diameter, traversed by an unusual number of parallel fissure

QUARTZ HILL. MINES ON LINE OF TUNNEL.

veins carrying gold and some silver, the richness of many of which has been satisfactorily proven.

According to the prospectus of the tunnel, "its purpose is to discover, cross-cut, drain, and operate at greater depths than is otherwise feasible, lodes of gold and silver, and to offer working facilities to mines discovered hitherto, and to afford an outlet and milling facilities to all at a minimum of cost."

The gold belt of Gilpin county has already yielded about $65,000,000, mostly in gold. Its annual production has occasionally exceeded $3,000,000. The largest producing mines have been worked continuously for 30 years. These mines vary in depth from a few hundred to 2200 ft., with no sign of exhaustion.

MINED-OUT STOPE.

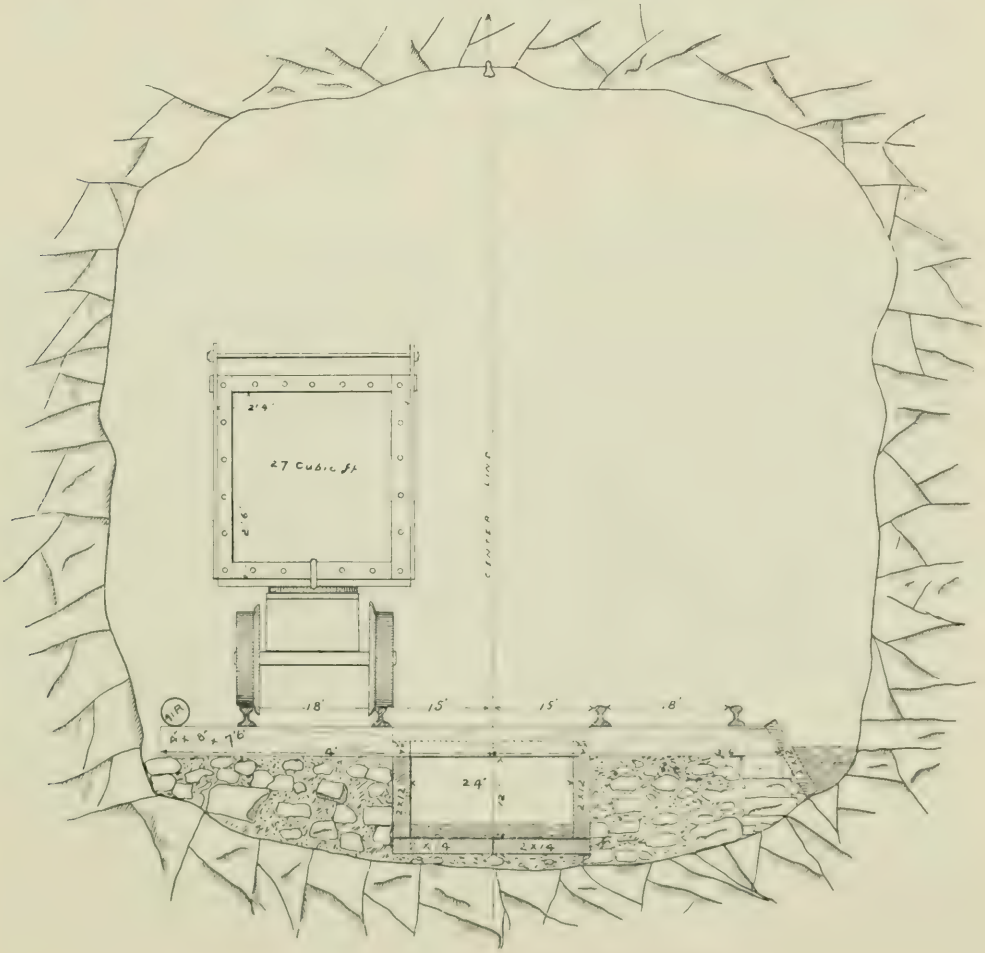
The arrival of the tunnel to these mines will be an enormous help to them, especially in getting rid of the water with which many of them are at present overburdened. Thus it is estimated that, while thirty six of the leading mines have produced $53,000,000, they have expended over $6,000,000 in hoisting and pumping and in sinking 73,000 ft. of shafts. One mine for many years raised on an average 40 tons of water for every ton of ore and rock. As I write, news of an appalling accident, verifying the use of the tunnel, comes to me. Sixteen miners have just lost their lives at Central city, the water of one of the mines breaking in on two other mines. Such an accident could not have occurred had the Newhouse tunnel arrived at the spot.

To sum up. The Newhouse tunnel will cut through virgin ground, in an old gold-mining region of wide extent and reputation, a great number of lodes yielding pay ore at great depths.

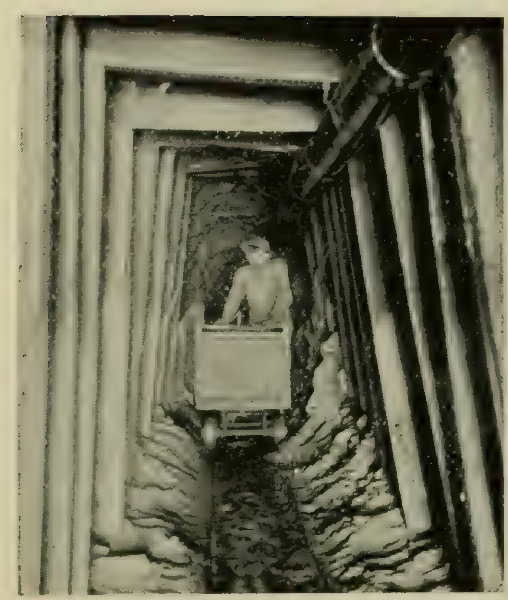
It will afford the cheapest method of working these mines. Thousands of tons of low-grade ore now lying idle in the mines and on the dumps will be handled at profit by the tunnel, subject to its tariff. Enormously expensive machinery operated by steam at great cost will be no longer needed. Great shafts to accommodate pumping and hoisting machinery will be no longer necessary. A natural drainage and ventilation system for the district will be established, inexpensive to maintain, subject to tariff and lucrative to the Argo Company.

The following notes descriptive of the construction of the tunnel were given to me by Mr. Walter H. Wiley, E. M., the mining engineer in charge of the development of the tunnel, who also personally made the photographs accompanying this article.

The tunnel is 10 ft. wide by 9 ft. high, with double track of 18-in. gage and a space of 30 in. between the tracks. Beneath this central space is a wooden drain 2 ft. wide and 14 in. deep, the top of the drain, even with the top of the ties, forming a foot-path. This box, as the flow of water is now small, is also utilized to convey the foul air out by means of an exhaust fan at the entrance of the tunnel. The



CROSS SECTION OF TUNNEL IN ROCK.

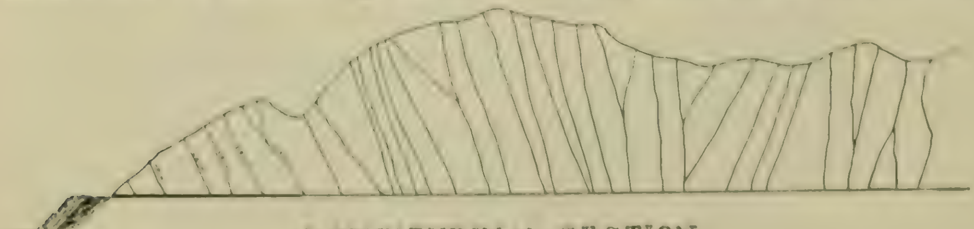


MINE DRIFT. HAND TRAMMING.

first 80 ft. are timbered with square 10-in. timbers, forming an arch overhead. For the rest of the way the rock is so firm and massive that no timbering is needed.

The rails weigh 30 lbs. per yard and are laid upon ties 7½ ft. long, which on one side are laid with the end close to the rail to allow room for an open side drain. The grade is 5 in. in 100 ft. At intervals of about 1000 ft. short cross-cuts are run in the sides of the tunnel, to which the workmen retreat when blasting takes place ; and in the one nearest the heading is the battery with which the shots are fired. The character of the rock is gneiss, frequently much banded with mica or hornblende ; sometimes crossed by large bodies of pegmatite, sometimes passing into mica-schist, and occasionally into a very hard, tough, black hornblendic rock. Two dikes of porphyry have been crossed. Also quite a number of small interstitial veins or veinlets, sometimes in a network and showing little faults and small movements, and crossing and re-crossing one another. They are mostly little quartz seams, with iron pyrites, bounded on each side with a dark reddish band of hematite formed by the oxidation of the pyrite.

Water trickles in at several points, with much iron oxid stain, which suggests that it comes from some ore body, perhaps of importance. The tunnel, at the time of my visit, was in about 3000 ft. The straight line of the tunnel is maintained by a surveyor, who has wooden plugs with screw eyes driven on the exact center line in the roof. By alignment with lamps suspended from these points the exact center is determined in the heading every day. This point being ascertained,



LONGITUDINAL SECTION

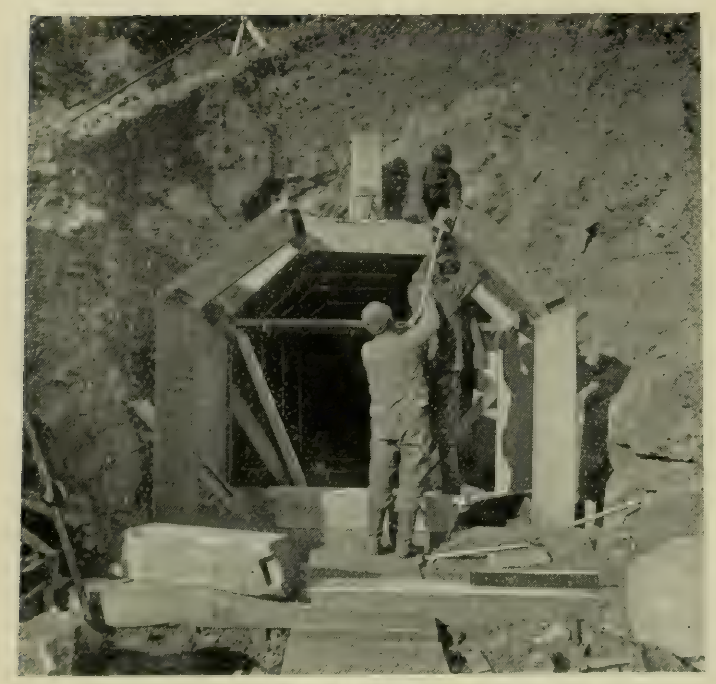
THE NEWHOUSE TUNNEL.

the workmen at the face paint a vertical center line down the heading, and commence work on either side of this. The drilling is done with two 3-in. cylinder, Leyner power drills, working day and night. The holes are drilled, usually five on either side of the center line and four or five nearer the sides of the tunnel. The first holes converge inwards, and the center is blasted, first taking out a wedge-shaped mass. The drilling is begun with a short drill about 2 ft. long, the point 2¼ in. in diameter; longer drills follow, the point of each of less diameter than the preceding one drilling a hole shaped like a telescope looking toward the eye-piece. The center-cut holes are 8 to 10 ft. long; the side ones, 6 to 8.

Dynamite is used,—100 to 175 lbs. each round. The ½-lb. sticks of dynamite are lowered into the hole, as many as sixteen sticks at a time, and firmly tamped by a piece of gas-pipe with a wooden plug in the end.

The 9 ft. holes are filled 6 ft. with dynamite, and the remainder of the hole to the top is filled with cartridges of fine dirt ready prepared. Prior to the tamping, the exploder is inserted, firmly imbedded in a stick of dynamite. This exploder is a small copper cap about 1 in. long, filled with fulminate of mercury. To it are attached two fine copper wires, one negative, the other positive, both thoroughly insulated with a rubber covering.

TRAMMING. MOUTH OF NEWHOUSE TUNNEL.



TIMBERING.

These wires come out of the drill hole at the side of the tamping. The wires from the different holes are united. Then one on each side is connected with the main leading wires from the battery. The last 50 ft. of the main wire are of a smaller and cheaper kind, and most of this is destroyed at each explosion.

The battery stands safely in a short cross-cut, some hundreds of feet from the heading, and to this cross-cut the men retreat before each explosion. When all are under cover, the arm of the battery is raised, rapidly lowered, and all the holes connected are exploded simultaneously. Previous to this, the drills are removed to a place of safety. The powder smoke fills the recess, and the men wait from 10 to 20 minutes before returning to the heading.

After the center-cut, the side round is blasted, and then a gang immediately begins to clear away a space at the heading for again setting up the drills; after this the broken rock is trammed out to the dump in train-loads drawn by mules.

In all, twenty-six men are employed, divided into two shifts of drill men and three for handling the rock. The ventilation fan is a Huyett and Smith No. 11 exhauster,—the blast wheel 26 in. in diameter, driven two thousand revolutions per minute by a 20-h. p. engine. The powder smoke and foul air are exhausted through the drain box before mentioned, which also carries the water, discharging through a trap at the outlet.

The compressor plant is in duplicate, consisting of two Norwalk compound 14 × 16 high-altitude compressors and two 80 h. p. boilers.

MOUNTAIN RAILROADS OF THE MINING REGIONS.

By James R. Maxwell.

THESE may be divided into two classes,—those built solely to serve the mining interests, and those built mainly for general work. Great care should be taken in the location of these roads. Too often hurried work is done, and in many cases directors would be surprised to learn how much such haste has cost. Changes can be made even after the grading has commenced. They may extend over many miles, and result in large saving, or in improvement of the alignment, and sometimes, happily, in both.* Or many times on a small scale, by changing the rate of a curve, or moving it ahead or backward, or swinging a tangent, a few degrees of curvature may be thrown out, or a cut or fill diminished in quantity.

Years ago an eminent engineer said to the writer: "A location should never be considered final until the work has gone so far that no more changes can be made profitably." That saying should be a rule for all new railroad work. Lines built solely for mining interests are usually projections or spurs of other roads, generally short, with heavy grades, and curves. An example of this class is shown at Butte, Montana, where the Union Pacific Railway was called upon to furnish transportation for the copper ores from the mines to the smelters over 30 miles distant. Butte station was in the bottom of the valley; the town and mines on the hillside to the north. Most of the mines were above the town. The extension was made to serve the now famous mines of the Anaconda Company. The grade required to reach the first of them (on the Anaconda vein) was 2.8 per cent., compensated for curvature at 0'.05 per degree of curve. On a later extension 4 per cent. was used. The maximum rate of curvature was fixed at 14°. Spurs were made to all the hoisting works, and, where possible, two to each,—the upper one to deliver material, the lower to carry away ore. The first to be finished was an ore spur to the St. Lawrence mine; the second served as an ore track to the Anaconda, and was extended so as to pass above, and deliver material to, the other mine. After these were finished, the mining company acquired large interests, on a parallel vein, farther north, and extensions were made to the hoisting works thereon, as well as to some belonging to other parties (see Map 1). One of these ore spurs was thrown off on the right, on a descending grade, and passed under the line it had left. It crossed by a tangent under a trestle, built on a maximum curve. The intersecting angle was 30°.* The spurs were also planned as impediments in the way of any other company that might desire to share the traffic. Each spur was on a level tangent at the ore house, but on a grade throughout the rest of its length. The spurs on the lower side descended in the same direction as their main line, but the others were switchbacks ascend-

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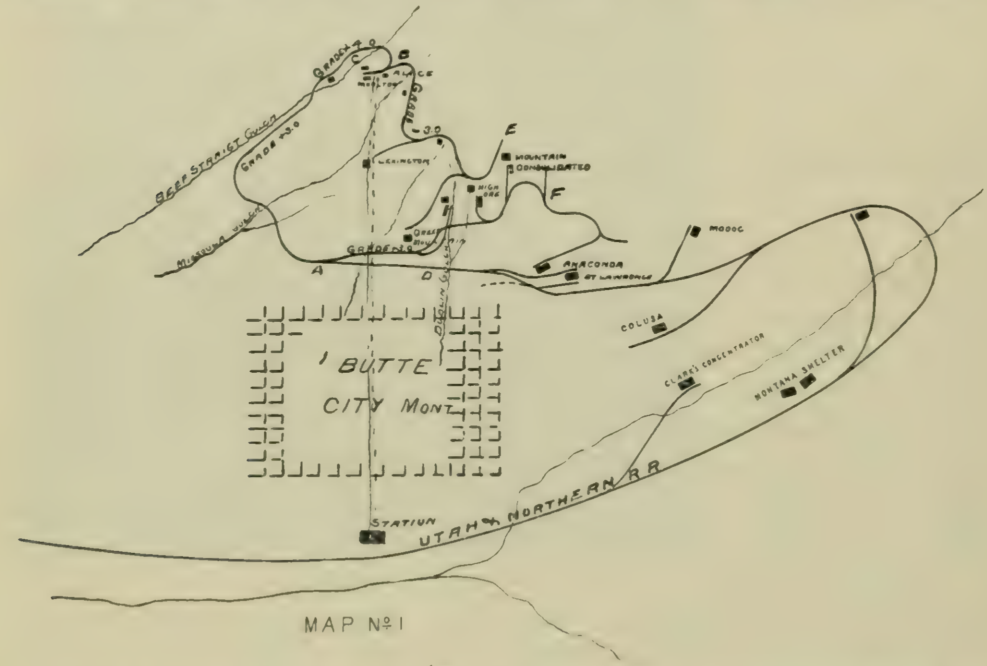
* An instance of this kind occurred in one of the territories some years ago. The road was well located; still, there seemed to be chances for improvement, and surveys showed that a saving of 124° in curvature, over a mile in distance, and about 60,000 cu. yds. of embankment, could be made by a bolder location.



MAP No. 1

SMELTER NO. I. ANACONDA, MONTANA.

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* The spur to the Colusa is also on the down grade; those to the St. Lawrence and the Anaconda are on ascending grades

ST. LAWRENCE AND ANACONDA MINES, MONTANA.

ing at the maximum rate of grade. Wooden trestles were used in crossing most of the large ravines, the intention being to fill them up later with waste material from the mines, if the camp held out long enough to warrant this. There was very little earth or other loose material available for borrowing. On the lower part of the work, the water of two mining ditches, and the discharge of some of the large

ON THE A. & P. R.R. NEAR THE SUMMIT OF THE ANDES.

gulches, were carried under the embankments by cast-iron pipes, but on the upper portion the culverts were made of heavy planks.

The smelters were built at Anaconda, a town laid out where this company owned a large tract of land and valuable water powers. It was reached by a branch from Stuart, a station on the Montana Union Railway, about 20 miles from Butte.* This branch has light work and moderate grades, but on the extensions, and spurs to the ore houses, the work is heavy, with steep grades and sharp curves. Many of the latter are of the maximum rate. The maximum grade used was 4 per cent. The upper tracks were to the ore houses and calciners, the middle ones to bring in coal and wood, and the lower ones to bring the other supplies and carry away the product. The smelters were built on a steep hillside, with the machinery placed in steps, so that the ore would descend by gravity from the ore houses to the crushers, thence to the concentrators, and finally to the smelting furnaces.

AREQUIPA, PERU. VOLCANO OF MISTI IN THE DISTANCE.

The approach to the first ore house was over a high trestle, on which the maximum grade and curve were used. The necessary change of grade and line before entering this house produced a curious-looking warped surface on the track.

The first plans were made for a daily traffic of 500 tons of ore, with the necessary amount of wood and coal to smelt it. The business increasing, more smelters were built, and 4000 tons of ore, with a corre-

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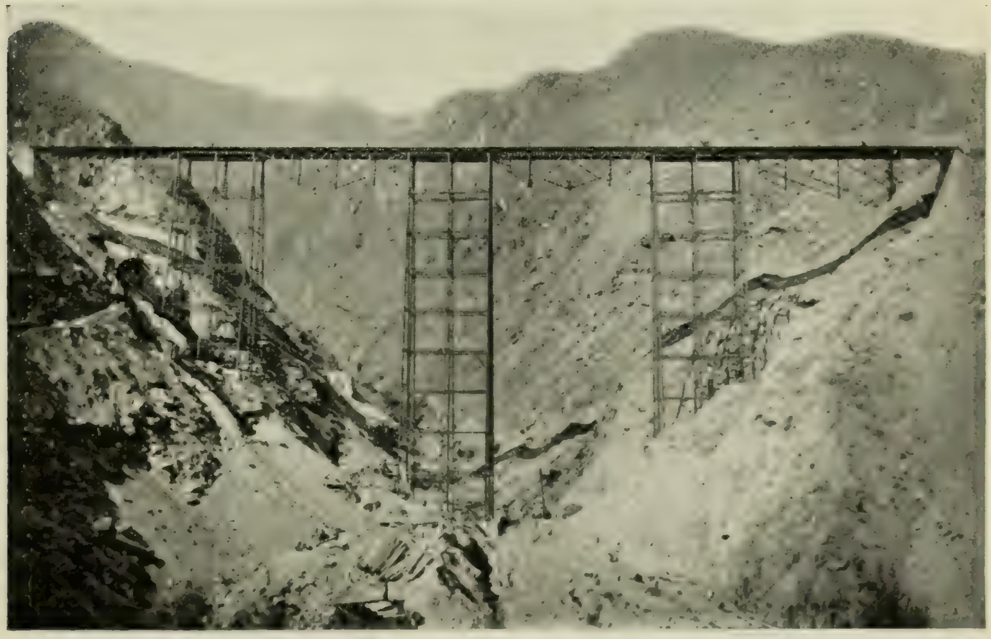
* This railroad connects the Union Pacific system with the Northern Pacific, and was jointly owned by the two companies.

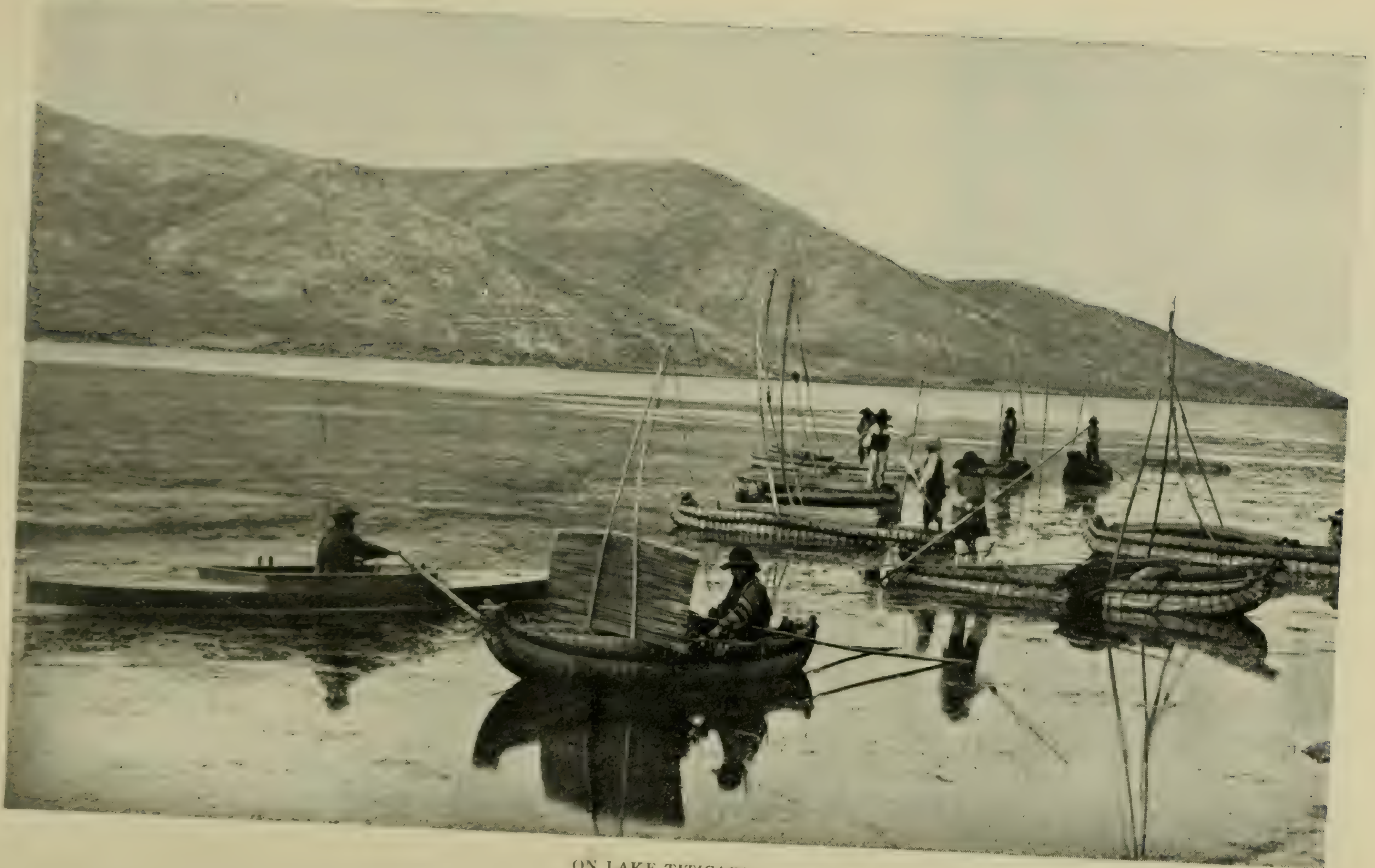
SAND DUNE NEAR LATOYA.

sponding increase in the amount of fuel, were used each day. This caused large additions to the yards in Butte and Anaconda, and led to a change in the line through Silver Bow Cañon. When the road was built, it was good enough for the business in sight, and probably for many years to come; that was before the magnitude of the mines was known. But the business increased until that short piece of line had a much greater tonnage than any other two pieces of the same length on the two systems combined.

The long ore trains were difficult to handle in the cañon, and



VERRUGAS BRIDGE, 256 FEET HIGH.

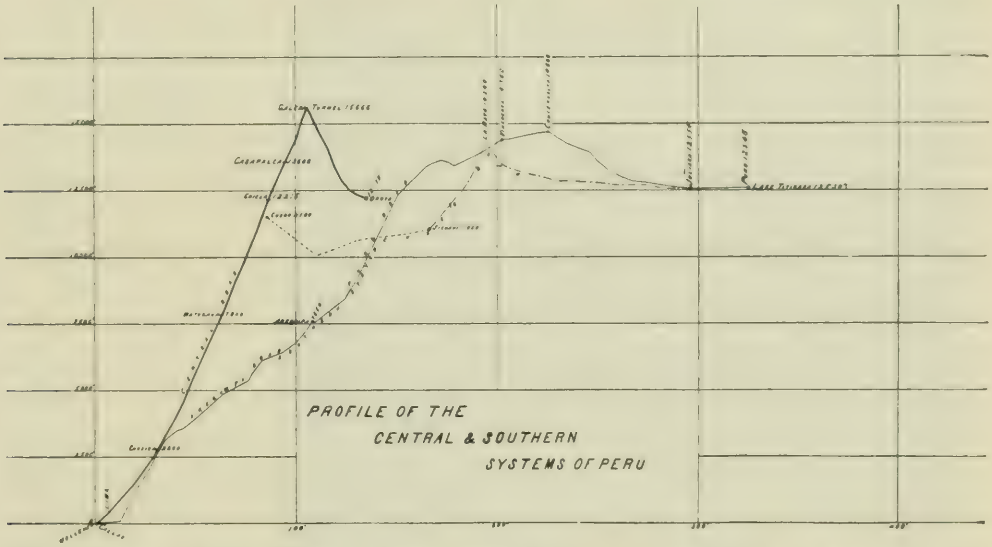


ON LAKE TITICACA.

liable to accidents, as the man on the engine could not see those in the caboose, nor they him, until the narrow part was passed; so this was remedied by straightening the line.

Of mountain railroads built mainly for general work examples are furnished in Peru, where a grander mountain range is encountered, and higher altitudes attained, than are possible in this country.

The highest of these, and the highest in the world, is the summit of the Central Railroad of Peru, where it crosses the Andes mountains at the elevation of 15,666 ft. above sea level. Two other summits on the Southern system are above 14,200 ft.* These roads were built by the Peruvian government to develop the country, as well as for military purposes. It fixed the route of each, and the standard according to which they were to be built. The maximum grade was 4 per cent. compensated on curves of less than 1968 ft. radius, and the minimum radius allowed was 393·6 ft. The contracts for these roads were specified, a lump sum to be paid for each. The contractor located and built them, subject to the approval of the government engineers.



Four of these are mountain roads, all beginning at ports on the Pacific ocean. Of these three were designed to cross the mountains, and to ultimately reach navigable water on some of the branches of the Amazon. The most northern of them, the Pacasmayo, began at that port, and was to terminate at Cajamarca† on the eastern slope of the Andes, with a branch to Guadalupe. The location was easy at first.

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* Galera tunnel is higher than any mountain peak in the United States except Alaska, and is exceeded in Europe only by two peaks in the Ural mountains.

†Cajamarca was one of the capitals of the Inca empire. An extension down the valley of the Tungurangua will get to navigable water in less than 300 miles, and make a shorter connection with the Atlantic, and probably have deeper water at the river port, than either of the others.

Leaving the port, it crossed some low desert land, and then ran up a valley to its head; thence by development across the mountains. Before leaving the flat country, a branch was started to the north, to Guadalupe. This approached so near to the coast that a short trail was made, and mule trains competed successfully for the carrying of sugar. It is probable that political influence had much to do with this location. The main line was built to the beginning of the maximum grade; the branch was finished, but none of the mountain work. The summit of this line is the lowest in Peru, as far as known.

Next to the south is the Chimbote road, which was not intended to cross the mountains. The gage of this is a meter;* all the others have a gage of 4′ 8½″. On the ascending grade the heaviest rate was 2 per cent. There is an adverse piece of grade of 3 per cent. that should never have been put in and will be taken out whenever this road is completed. Its initial point is Chimbote, on the bay of Ferrol, one of the best natural ports in the country. From there it runs over about 12 miles of smooth desert to the Santa valley, and then up to Huaraz and Recuay. To the latter town the distance is 165 miles, with a rise of about 11,000 ft. The Santa river is the largest stream in the country on the western slope. It rises on the east side of the Sierra Negra (Black Range), and runs northward between it and the main range, known there as the Sierra Blanca (White Range). About half way from its source, it turns abruptly to the

DEVELOPMENT AT HUSAMAYO, A. & P. R.R.

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* The use of the metric system is compulsory on all public works.

left, and breaks through the Black Range to the Pacific ocean. The cañon thus formed is extremely rugged; so much so that, previous to the advent of the railroad, the people in the upper valley could reach the coast only by crossing over the intervening range through passes more than 16,000 ft. above sea level. In doing this they had to make two dry camps; they carried water for their own use, but none for the animals. The principal article of export was high-grade silver ore.

A. & P. R.R., 25 MILES FROM AREQUIPA.

The location from the port to the valley was by long tangents with a few light curves. In the lower part of the valley were some stretches of tropical jungle each several miles across. This was so interlaced with vines that the cutting of it down was the least part of the work. Progress was very slow in the rugged part of the cañon, especially in one place about three miles long that had never been entered. This was the worst place found on any of the roads. Farther up there is a similar one that has not yet been visited by man. The line and levels were carried over it by triangulation from points high up on the hillsides. The engineer who made this survey said that the walls of the cañon were so steep and so near together that he could see the river only in a few places.

Through the close part of the cañon the work on the preliminary line was very laborious; the climbing required steady nerves, and cool heads were necessary at the instruments. A force was employed to cut paths, and frequently places for the instruments. Before the locating party got to work, these paths were replaced by a good mule trail. Suspension bridges were used where it was necessary to cross the river. They were an improved form of the Inca bridges, being supported by wire ropes. They seemed very shaky and insecure, but a large amount of travel was made by them, and no accidents were ever reported. The building of these paths and trail formed a large item in the cost of the Chimbote road. The railroad was generally on the left bank of the stream, and the mule road wholly so until near the upper end of the cañon. The camps were mostly on the same side as the trail; but, when the work was on the opposite bank, the men crossed, by means of a rope stretched over the stream, on which ran a single block crarying a boatswain's chair. This method of crossing was agreeable enough while on the down grade, but, after passing the middle, it was not, the jerking causing sensations similar to those felt when standing near the stern of a vessel in a heavy seaway. Where it was impossible to pass over the centre line in locating, some very fine work was done by the engineers in fixing the line and grade points by triangulation. On construction the same methods were used.

TUNNEL. HUSAMAYO DEVELOPMENT, A. & P. R. R.

On the lower part of the road no culverts were required, except for irrigating ditches, as there was no rainfall or springs to provide for. The dry clay and sand would stand at a rock slope.*

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* The road passed at the foot of a cliff of this kind, where the slope was the wrong way; so the overhanging part was blown off, solely for appearance's sake, no danger whatever from it being apprehended.

Another, and an unpleasant, feature of this cañon was the continual falling of stones, mostly small ones, though occasionally large pieces would come crashing down. When one of these struck the track, it smashed that part very thoroughly. Several fatal accidents to men and animals occurred in this manner.

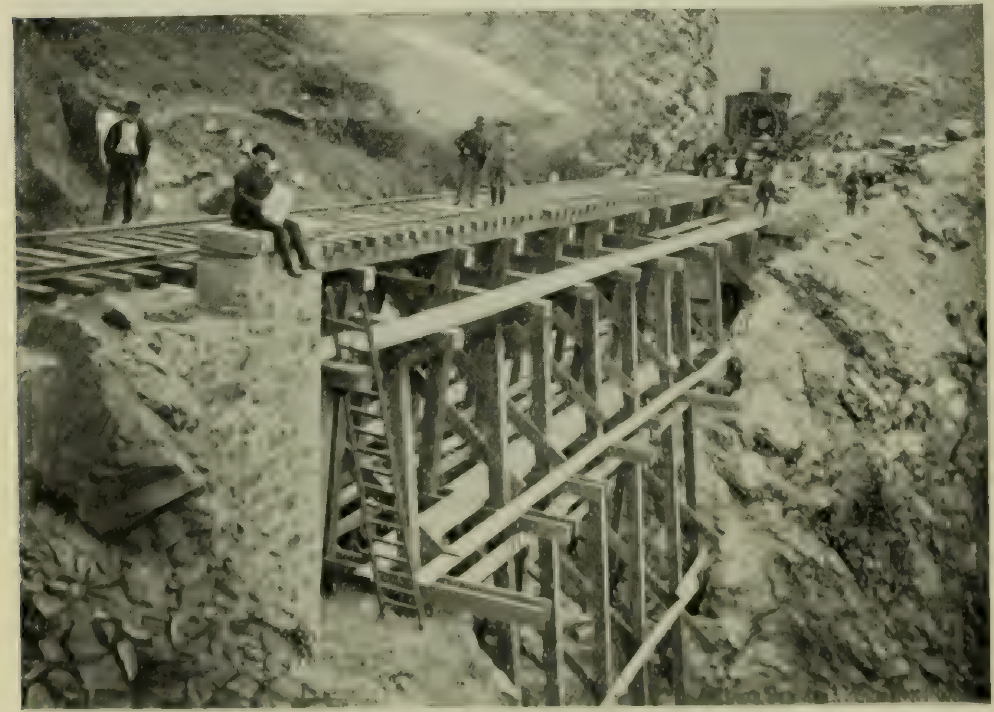
LEFT ON QUINTALA BY THE TRAIN.

Ten tunnels are built; the upper box cañon will probably require many more. These are in solid rock, and no lining was needed in any of them.

When cliffs were to be blown down, drifts were run in, with a cross drift at the end, and chambers at the ends of this. This work was contracted for by the running foot; it was surprising to see in what a small hole the men could work. The salient features of this road were the great difficulty and cost of getting into the cañon with the preliminary and location, and to get the men and supplies in while grading. A number of mules were lost by being crowded off the trail by others when they met on a narrow path high up on a hill-side.*

The second Trans Andine road, now known as The Ferro Carril Central del Peru, was completed early in 1893; it extends from Callao to Oroya, a distance of 136.5 miles. From the coast to summit (Galera tunnel) by rail the distance is 106.2 miles; the difference in elevation is 15,656 ft. Oroya is 30.2 miles farther, and over 3300 ft. lower. It is said that there are valleys near Lima that lead up to passes better than Galera; but, for other than engineering reasons, none of these were chosen.

Considering the little time given to the engineers, the road is located in detail remarkably well. The only alternative was a pass at the head of a small valley near Casapalca. From observations and barometric measurements this route seems feasible. If it had been adopted, the tunnel would have been about the same length as Galera,



TEMPORARY TRESTLE USED WHILE RIVETING BRIDGE.

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* The Chimbote road will have a large traffic when the mines of hard coal are reached and a still larger and steadily-increasing business when the upper box cañon is passed.

several small tunnels would have been left out, and about 6 miles in length and 600 ft. in elevation would have been saved.

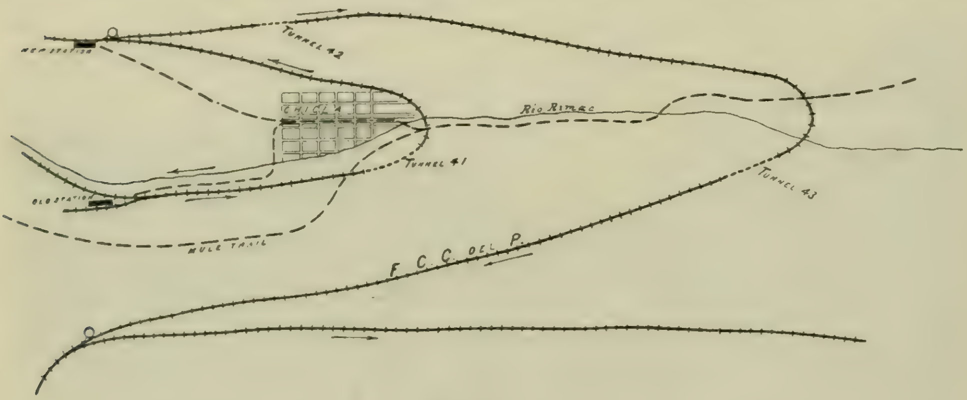
There was not so much dangerous climbing required here as on the Chimbote road, and the stream was not so difficult to cross, but far higher altitudes were reached; and it makes a very material difference in the amount of work done, either in locating or grading, whether the barometer is at (or near) 30 in., or gets down below 20.

TEMPORARY HOUSE OF INDIANS AT WORK ON R.R.

When the road was located, the only feasible plan of working it seemed to be that of using switchbacks. There are eight of these,—seven of them on the western slope. The largest is at Chicla (see Sketch Plan 2). There the valley rises faster than the maximum grade, but is wide enough to turn in, by using a curve of the minimum radius. Then, after running back as far as the slope of the hill permits, a switch and a turn-table are put in, so that the engine can be turned and taken to the other end of the train. The line runs ahead for about a mile, when another turn is necessary; again it heads down stream, but steadily climbs the 4 per cent. grade, until it runs into a corner, just opposite to the other switchback. There another switch and another turn-table are used, as before, and the line starts once more on its original course.

By this means a gain of over 700 ft. in elevation is made. The characteristic points of this road are the great altitude attained, the large bridges used (some at great heights), the liberal use of retaining walls, and the great number of tunnels.

There were fifty-six when the road was finished,* all except the summit being on the western slope, in a space of 24 miles. Seven of these are above 12,000 ft., and nine more over 15,000 ft., above sea level. The summit tunnel (Galera) is 3654 ft. in length, and is one of the few that are on tangents.†



MAP NO. 2.

The Southern system consists of three roads, two of which are completed. They are the Arequipa, 107 miles; the Puno, 218 miles; and the Cuzco, with 126 miles of track laid and located, and work done on 84 miles more. The beginning was made at Mollendo. It should have been at Islay, 7 miles farther north. This is a better port, and nearer to Arequipa, but some influence determined otherwise. After that, the line is well located, especially on the Cahuintala development, which rises over 2200 ft. in 15 miles of track, while the ends are only 5 miles apart on an air line. Then it crossed over a desert and up the valley to Arequipa. On the desert there are a great number of sand dunes, all moving in the same direction, many of them towards the line; when one of them gets to the track, it *will* cross; so the section men help it over. An expensive item in building from the sea, for over three-fourths of the line, was the water supply. At the start this was distilled from sea water; then more was needed, and it was hauled long distances. This cost about $5000 per mile. Now a pipe line supplies all on that section.

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*One more has since been added to that number. This was on old work near the Verrugas bridge, and was rendered necessary by a storm which started a heavy slide.

†At Casapalca, 13,700 ft. above the sea, is the largest smelting works in Peru. This is served by two short spurs from the main line. The silver mines are all at high altitudes, Cerro de Pasco being over 14,000 ft. Those in the district near Casapalca are nearly 15,000, and some farther east are about 17,000.

The second road begins at Arequipa at an elevation of 7550 ft.; it crosses the first summit when out 118 miles, rising 7116 ft. more, and then passes on to Puno on Lake Titicaca, which is 100 miles farther and 2130 ft. lower. There are several developments on this road,—one, exceptionally fine, at Husamayo. It is about as long as the one on the Arequipa road.

The third road of this system branches off from the second at Juliaca, 29 miles from its terminus. It runs nearly due north, and reaches the summit of the range that separates this interior basin from the Amazon valley in 96 miles and at a height of 14,240 ft. above sea level. The descent to Sicuani is made in 30 miles, with a fall of 3140 ft.

A VIEW ON CAHUINTALA.

This town is on the Ucayali, one of the larger branches of the upper Amazon. Sixty miles farther on the line leaves this valley, and runs up a branch to Cuzco, 24 miles away and nearly 1500 ft. higher.

On the whole of this system there was, practically, no clearing to be done, and long tangents could be had. The location was easy, except on the developments. There were long pieces of light work on all three roads, and the average quantities would be considered but medium work. Of this but a small proportion was solid rock. All of these roads entered the mining regions. The Central took up coke and brought down silver and ore for shipment abroad; all had some business in hauling ores. A farther extension of the three northern roads will result in a large coal traffic.

FUTURE METHODS OF SEWAGE PURIFICATION.

By W. L. Hedenberg.

EXPERIENCE teaches us that at the present day apparently the best results in the way of purifying sewage are obtained by combining some of the simpler forms of chemical precipitation with the filtering of the effluent through land. This combination, however, is exceedingly costly, and therefore cannot be adopted by other than wealthy communities.

As by far the greater number of places in need of sewerage systems are towns or small cities, where only a moderate appropriation can be obtained, some cheaper or more inexpensive method has to be adopted. Recourse is then had to mechanical filtration and turning the effluent into some stream ; filtering the sewage through prepared filter beds ; or precipitating the sewage by one of the numerous chemical methods.

Mechanical filtration in no wise purifies the effluent, but simply extracts the insoluble matter, and should be recommended only when but a small appropriation can be obtained and where it is proposed to turn the effluent into a large body of moving water.

Filtering the effluent through soil necessitates a considerable outlay of money for the land and labor preparing it ; in many cases it involves a pumping station with all the expenses thereof, and is often beyond the means of a small community.

Chemical methods are in most cases complicated and expensive, and the results obtained doubtful. Analysis certainly shows that a considerable amount of impurity may be removed by precipitation and the number of bacteria reduced, but a large amount remains, and, although the effluent may be odorless and almost colorless, if it is kept for a few hours the odor in most cases becomes unbearable.

Almost every conceivable combination of chemicals has been tried, either in this country or abroad, and nothing has as yet been discovered that, taking everything into consideration, can be called a success. Either too little chemical is used, with a view of keeping down expenses, as was the case at Worcester, Mass., and the effluent goes out impure, or a large amount of chemical is used at an enormous cost, and the effluent is turned into a stream so full of lime, alum, copperas, or perchlorid of iron that it is impossible for fish to live in the neighborhood.

In the United States land is much cheaper than in France, Germany, and other European countries. But in years to come, as this country becomes more thickly populated, large areas suitable for the filtration of sewage near our cities will entail an enormous outlay of money. Bearing this and the mediocre results usually obtained by chemical methods in mind, it would seem about time that engineers were branching out into some new line of inquiry, with a view of discovering a method by which liquid wastes may be as thoroughly purified as by filtering through sand or earth. From all appearances the means are at hand ready to be experimented with, and a few of the more progressive engineers, especially abroad, have already directed their attention to it. The writer refers to electricity, which will undoubtedly be the purifying agent of the future.

Two well-known methods of manufacturing a disinfecting liquid by electricity have appeared during the last few years. One is known in France as the Hermite system ; the other, in this country, was invented by Mr. Albert E. Woolf, and is known as the Woolf process.

These two systems are very similar, and differ only in detail and method of application.

Mr. Hermite, bearing in mind the old saying that "an ounce of prevention is worth a pound of cure," aimed at destroying the cause of disease at its birth, while the Woolf system undertakes to render sewage, garbage, or other matter that has already undergone decomposition sterile and harmless.

In both of these systems the disinfectant is a liquid obtained by passing a high current of electricity through sea or salt water. The Hermite process has been tried in a number of cities in France and in several towns in England. In the former country plants have been installed at Havre, Brest, Paris, Nice, Loriente, and Monte Carlo. The Hermite system usually consists of a closed iron vessel in which the electrodes are situated, a dynamo, the necessary engines and boilers, and a supply of sea water, with pumps and distributing mains.

The negative electrode is made up of discs of zinc, which, when in operation, revolve. The positive electrodes are fixed between each pair of discs, and consist of glass tubes covered with a coating of platinum. The iron tank has at the bottom a pipe with perforated holes, through which the sea water is admitted.

The action which then takes place, expressed in chemical symbols, is about as follows :

	Negative electrode.	Positive electrode.
H_2O	H_2	O
Na Cl	Na	Cl
Mg Cl_2	Mg	Cl_2

Thus the water is decomposed, hydrogen gas being liberated at the negative electrode and oxygen at the positive. The sodium chlorid suffers decomposition, the base sodium being set free at the negative electrode and chlorine at the positive. The magnesium chlorid is broken up, the base magnesium appearing at the negative electrode and chlorine at the positive. From the bases and free chlorine produced in this way hypochlorites are formed, which are undoubtedly the active disinfectants.

In this system the idea is to use the disinfecting liquid as ordinary water, both in the public sewers and also in the closets of private This would require considerable piping ; so in most cases, as at Worthing, England, the sewers alone are flushed.

At Nice it is claimed that in time of heavy storm the disinfecting liquid is so diluted that it loses a great portion of its efficiency. This would appear to be a reasonable conclusion, notwithstanding Mr. Hermite's argument to the contrary, as the majority of sewerage systems throughout France are those known as the combined system, in which both the household wastes and storm waters are admitted.

Such a method of disinfecting would probably give much more satisfactory results in this country in small cities and towns where the separate system of sewers exists. Arrangements could be made at a comparatively small cost to distribute the disinfecting liquid to the flush tanks of a system allowing them to discharge automatically their contents directly into the sanitary sewers.

Experiments with the Hermite system were carried out on the most extensive scale at Brest, where the sewage of 11,000 people was treated. Dr. Pitau, in an official report dated February 21, 1894, says : "In a word, the experiments which I have made enable me to conclude that electrolyzed sea water is a perfect disinfectant and an excellent antiseptic, which very rapidly destroys all microbes, even the most tenacious of life, on the condition that these microbes are brought into contact with the electrolyzed sea water."

Mr. Draghi, a chemist on the committee to examine into the Hermite system at Nice, estimated from the experiments made that the cost of the system per year per inhabitant is 48 cents.

At Havre there were two separate plants consisting of two 35-h. p. engines with double electrolyzers. Five centrifugal pumps were constantly in use ; three forced the disinfectant into an elevated storage reservoir, a fourth was used to convey a supply of sea water, while the fifth circulated the liquid through the electrolyzers. The experiments showed that 440 gallons of disinfecting liquid, containing about 35 grains of chlorid per gallon, could be produced in an hour at a cost of $13.30 a day.

If, as Mr. Hermite claims, the disinfectant may be diluted a great number of times and still retain its purifying qualities, by thoroughly mixing the liquid at the rate of 440 gallons per hour with the sewage of a community as it flows into settling tanks, excellent results should be obtained at a much less cost than would be incurred in supplying every house with the disinfectant. As can be readily seen, the principal objection to the Hermite system would be the necessity of connecting the sink, drain, and closet in every house of a city with a special supply of disinfectants, entailing a net-work of pipes similar to that of a water-supply system.

The Woolf process is similar to that of Mr. Hermite, in that the disinfecting liquid, which is known as electrozone, is obtained by passing a large current of electricity at a low voltage through sea or salt water. The water to be electrolyzed is pumped into a large vat or tank, in which is placed a platinum zinc couple. The platinum electrode consists of a copper core with a platinum coating .003 in. in thickness.

The chemical action which takes place, when the electrozone is brought into contact with sewage, is about the same as that in the Hermite system; the chlorids and bromids in the sea water are converted by the high electric current into hypochlorites and hypobromites, a portion of the chlorine replaces the hydrogen which is liberated from the organic matter, and the liberated hydrogen unites with chlorine and forms ozone, which tends to further purify the organic matter.

The first plant was installed during the summer of 1893 at Brewster, N. Y. This plant consisted of a 15-h. p. engine, a dynamo capable of generating a current of 700 amperes at a pressure of 5 volts, a vat of 1000 gallons' capacity containing the electrodes, with a supply tank designed to hold 3000 gallons. The electrozone was allowed to flow into the sewer, and was also sprayed into Tonetta brook, at a rate of 1 part hypochlorite to 100,000 of water.

A bacteriological examination made by the New York board of health showed the following striking results:

NUMBER OF BACTERIA
per cubic centimeter.

Before treatment.	After treatment.
32,600	8
22,000	42
2,353	12
4,134	0
7,000	0

Mr. Woolf stated to the writer that he considered the plant at Brewster sufficient to thoroughly disinfect the sewage of 30,000 people, if run to its full capacity. Such being the case, assuming a coal consumption of 6 lbs. per horse power per hour at $5.50 a ton, the cost of fuel per annum would amount to $2168.10. Three assistants, at a total cost of $2737 a year, with sundries at $300, would make the running expenses $5205.10, or a cost per inhabitant per year of 17 cents.

About a year ago the Woolf system was installed at Danbury, Conn., for the purification of the sewage. The plant consists of a 40-h. p. engine and a dynamo giving a current of 1000 amperes at about 5 volts. The disinfectant is generated in a vat situated near and above a tank through which the sewage is made to flow. The electrozone is allowed to run into the tank by gravity, the flow being regulated by a valve. The disinfectant and sewage are thoroughly mixed by an agitator in the tank, and, as the sewage rises, it overflows into a line of pipe which discharges into the river. The cost of running the plant is about $12.50 per day,—$7.50 for labor and $5.00 for salt, oil, and fuel. With a population of 16,552, the cost per inhabitant per year amounts to 27 cents.

The results obtained so far have been good according to analyses; complaints have been made, however, by persons along the river, owing to the fact that the heavy part of the sewage is allowed to find its way into the stream. This should very easily be remedied by adding a settling tank, or by the use of screens.

The problem at the present time, in inland sewage disposal, seems to be how to dispose profitably of the sludge after the liquid has been clarified and turned into some water course. At a few localities, such as East Orange, N. J., and Chautauqua, N. Y., the sludge is pressed into cakes by means of a filter press, and is then in a harmless and unobjectionable form. The cakes are easily handled and make an excellent fertilizer. But in most cases there is no market for them in the immediate vicinity, and in many districts where the soil is naturally fertile a premium has to be paid for the removal of the sludge. In some localities it is allowed to accumulate in large quantities near the disposal plant, and occasionally an effort is made to bury it at the expense of the community. In England, under similar circumstances, special furnaces were erected in some cases, and the sludge was disposed of by cremation. It was found that, after once starting the fire, the sludge, in cakes containing in the neighborhood of 20 per cent. of moisture, was self-consuming. The vapors and poisonous gases given off were passed through a furnace in order to render them harmless before allowing them to escape through the chimney to the open air. This method, as will be readily seen, necessitates an extra outlay of money, and is against the principles of economy, as the sludge theoretically ought to partly, if not entirely, pay for running the plant. The cakes, as they come from the sludge press, usually contain about 40 per cent. of moisture. By reducing this amount, and heating the cakes sufficiently to expel the greater portion of the poisonous vapors, the sludge might make good fuel, resembling to some extent peat, and could be used instead of coal for generating steam. If this could be accomplished, the great problem of how to dispose of the sludge would be solved in a way that would yield no little revenue.

An ingenious method for the profitable use of the sludge is that known as General Scott's sewage cement process. After the heavy matter has been precipitated by the addition of lime and clay to the crude sewage, and the effluent has been disposed of in some way, the sludge is burned by intense heat and then ground into cement. The burning of the deposited matter with the mixture of lime and clay renders the cement inodorous. An excellent quality of cement can be procured in this way, it is claimed. The method has been tried at Ealing and Birmingham in England ; at the latter place, however, it was not remunerative, and was abandoned.

It will be found interesting to compare in a general way the methods of sewage purification usually adopted with the purification by electricity. In determining the cost per inhabitant per year, the interest on the first cost of the plant itself is omitted in every case, the aim being to compare the actual running expenses of the different plants per year per inhabitant. In the case of intermittent downward filtration through prepared filter beds or broad irrigation, the interest on the cost of the land and its preparation has been added to the cost of labor, fuel, etc., in determining the cost per year, as in this method the land is the means of purification just as chemicals are in the chemical precipitation method.

An excellent example of the purification of sewage by a combination of chemical precipitation with the filtering of the effluent through land is to be found at East Orange, N. J., a wealthy suburb of New York, with a population of 13,283. The sewage, on reaching the disposal plant, is thoroughly mixed with lime and sulphate of alumina. It is then made to pass slowly through settling tanks, where most of the solid matter is precipitated, and from which, after passing upward through coke, the partially clarified liquid flows to the filtration area. This area consists of about 14 acres of land, thoroughly under-drained and laid out in beds. As the soil was very retentive, artificial beds of coke and gravel were added. The cost of operation of this plant was given for 1890–1891 at $8700 per year. The total cost of the disposal plant, including land, underdraining, machinery, etc., was $95,847.80. The cost of land and preparing the disposal beds was $20,749.20.

Adding the interest on the last figure at 4 per cent. to the cost of operation, we find the total cost of running for one year to be $9529.97, or, with a population of 13,283, a cost per inhabitant per year of 71.7 cents.

An analysis of the effluent, made by Professor Leeds, of Stevens Institute, after the chemical treatment, as it leaves the coke filter, showed a large amount of unoxidized sewage. The effluent was turbid, with an unpleasant, musty smell.

Another analysis of the final effluent, made as it came from the underdrains and ran into the brook, showed an almost entire disappearance of the nitrogenous organic matter, the effluent being about as pure as the water usually found in country streams.

South Framingham, Mass., purifies its sewage by intermittent downward filtration combined with broad irrigation. This town in 1890 had a population of 9239. The sewage is pumped to the farm, which consists of about 62 acres, 12 of which are laid out into beds and thoroughly underdrained. The original cost for the whole system, including 5 miles of sewers and the disposal plant, was $145,000. The cost of maintenance during 1891 was $6500. The cost of land and preparing the beds was not given separately, but was probably not less than $30,000. Adding 4 per cent. interest on $30,000 to the cost of maintenance, we find the total yearly expenditure to be $7700. With a population of 9239, the cost per inhabitant per year would be 83.3 cents. The analysis of the effluent after treatment, made by the Massachusetts board of health, showed that most, if not all, of the free ammonia, albuminoid ammonia, and bacteria had been removed. Consequently the effluent was about as pure as ordinary potable water.

The well-equipped chemical precipitation plant at Chautauqua, N. Y., on the south shore of Lake Chautauqua, furnishes an excellent opportunity of studying the results obtained by this method and the cost of maintenance. The population of Chautauqua varies at different seasons of the year, as it is a summer resort. The average population, however, is about 4000. The plant was ready for use in July, 1893. The chemicals used are lime, alum, and copperas. The sludge is pressed into cakes by means of a filter press, so as to be more easily handled and disposed of. The cost of operating the plant, including chemicals, fuel, and labor, is given at $2299.50 a year, or, with a population of 4000, a cost per inhabitant per year of 57.4 cents.

The analysis of the sewage and effluent made by Professor Perkins of Union College showed that 80 per cent. of the solid and 76 per cent. of the albuminoid ammonia were removed by precipitation. The effluent of Chautauqua contains, however, about eighteen times more albuminoid ammonia than the effluent which comes from the coke filter at the East Orange works. In short, the sewage is only partially purified, but, as the effluent is turned into Lake Chautauqua, which is a large body of water, no harm arises from it.

The cost of the various methods per inhabitant per year are, therefore, as follows :

Hermite System, Nice	48
Woolf System, Danbury, Conn	27
Chemical and Land, East Orange, N. J	71.7
Land Filtration, S. Framingham, Mass	83.3
Chemical, Chautauqua, N. Y	57.4

The purification of sewage by electricity is in its infancy. It is safe to prophesy, however, that in years to come electricity will play an important part in sanitation. So far the methods of applying the disinfectant to the sewage are rather crude, and could be greatly improved upon. A step has been taken apparently in the right direction by an English chemist, named Webster, who, availing himself of the fact that most crude sewage contains a large number of chlorids, passed the sewage itself through the electrolyzers and disinfected it directly. If there was not enough chlorine in the sewage, some was added. Iron electrodes were used in this method, and consequently iron and chlorine were liberated by the current. The chlorine is the disinfectant, while the iron liberated unites with oxygen, forming a precipitate of oxid of iron, which carries down most of the suspended matter. As in most cases chlorine would have to be added to the sewage from an external source, and as chlorine is a rather expensive chemical, this process might become exceedingly costly. The same results probably would be obtained at much less expense by adding a saline solution to the crude sewage.

In any case, the results so far obtained by the different electrical methods justify careful study and research in this line by all progressive sanitarians.

UNDERFLOW AS RELATED TO IRRIGATION.

By H. V. Hinckley.

UNDERFLOW is the name which, locally at least, is most commonly applied to the sub-surface waters of the "Great Plains," whether under the beds of the streams, the valleys, or the surface of the plains generally. Prof. Hay says :[*] "It would be best to restrict the term underflow to the proved sub-water of alluvial valleys, and possibly to that of some of the basin regions of the Southwest. The common well-diggers' term, 'sheet-water,' may very appropriately be used for the bodies of water which are so abundant under the higher levels of the Great Plains." Mr. Gregory[†] calls the sheet-waters "underflow." For the purposes of this article, and for reasons which may be apparent hereinafter, the term underflow is assumed to apply to all recoverable sub-surface waters anywhere, provided they are above sea level and without gas, or artesian, pressure.

A much mooted question has been whether the underflow really flows, and if so at what speed. Residents, in sinking wells in the sands and gravels of the plains, report strong currents of underground water flowing usually in the direction of the general slope of the country, but at times more nearly toward the nearest valley or stream. Conservatives, however, tell them that the apparent current is simply that which is due to the pumping from the well, and that the water naturally comes in from the up-hill side. The statements of numerous well-owners to the effect that, when no pumping is being done, a straw floating in a well invariably goes to the down-hill side of the well are generally considered to be illusions of water-supply enthusiasts. One prominent authority (?) says there can be no flow of water in sands because the capillarity thereof must nullify any tendency to lateral motion. Another prominent authority, who admits that lowering the surface level of water in a well increases the flow into the well, still insists that the flow of water in the sands or gravels of any valley must be independent of the slope.

Mr. Follett[§] failed to find any flow in the silted surface sands of the Rio Grande bed near El Paso ; he also failed to find any flow in the sands and gravels of Cherry creek bed at Denver, having a slope of about 30 ft. per mile, although he noticed *incidentally* that a hole dug in the bed of the creek "would instantly fill with water." It is interesting to note that the city of Denver has drawn off from the bed of this creek by gravity from 2,000,000 to 9,000,000 gallons a day. In accounting for the disappearance of rain water, Mr. Follett computed the rate of movement in the sands of the Frenchman Valley, where it crosses the Colorado-Nebraska line, to be $\frac{1}{6}$ in. per minute. An article* by him had for its title: "Can the So-called Underflow of the Semi-Arid Region be Utilized for General Irrigation?" and among its conclusions the following: "The rate of movement in the sand is very slow. . . The amount which may be drawn from it without permanently lowering its level is small. . . The supply is not such as to warrant large expenditures in constructing plants intended to obtain water sufficient for irrigation. . . Even if momentarily successful, as a plant would be, drawing down the surface of a lake with no *outlet*, the supply will be exhausted; in other words, the water surface will be permanently lowered, and disaster to the irrigation plant will follow." In the government report† he says: "It must be remembered that the annual precipitation on this (Great Plains) region is small and the evaporation quite large; and, after taking into account what runs off in storm-water channels, the amount that finds its way into the earth below, where no loss can occur from evaporation, on the average must be very small."

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[*] U. S. Senate Ex. Doc. 41, Fifty-second Cong., "Report on Irrigation, 1893," part iii., p. 35.

[†] Ibid, part iv., p. 28.

[§] Ibid, part ii., p. 35.

It is certainly best to be on the conservative side of the question, but any logic, arguments, or scientific statements having a tendency to belittle the underflow have not been pleasantly received by dwellers in the Arkansas valley (for example), who insist that the underflow has a lively gait. There have been advanced by students of the subject three general ideas as to the source of the underflow; first, that it comes, far underground, partly or wholly, from the mountains; second, that it is forced up from the "bowels of the earth" by some mysterious agency of nature; third, that its only source of supply is the rainfall. It has become evident that the underflow is too much misunderstood,—its laws, if any, too (entirely) unknown.

The public importance of the underflow and the necessity for understanding it may be appreciated upon consideration of the following propositions: Uncle Sam's population doubles every 30 years. This means sixty or seventy million more people to be provided for by 1925. He may be "rich enough to give them all a farm," but his available farms are in the arid and semi-arid regions, where rainfall is inadequate for successful agriculture, and irrigation development is the only recourse. The certain increase of population, the urban unrest of to day, and the contentedness and prosperity of irrigation producers in communities which are properly founded (for or by the people) point conclusively to the coming empire in arid America. That water-supply must be the first course in the foundation of this empire finds an unfortunate illustration in the fact that a third of a million people have abandoned the lands which Uncle Sam had given or sold to them in western Kansas alone, because the rainfall was insufficient or improperly distributed to produce crops, and they had not been advised as to whether underground waters could be successfully and profitably raised, by pumps or otherwise, for irrigation. Irrigation is the only insurance that pays annually the full face of the policy. Of the arid area (one billion acres), Major J. W. Powell, late director of the United States Geological Survey, estimated that a hundred million acres may be eventually brought under irrigation when all the sources of water-supply (or, better, all the methods of conservation, for there is but one source of supply) shall be fully utilized. This area will support, directly and indirectly, under thorough cultivation, from three to four times the present population of the Union. Up to this time less than one-tenth of this area (stated by two authorities as 4,000,000 and 8,000,000 acres) has been so reclaimed (and cultivated) ; and, while many mistakes, large and small, have been made, and much capital has been lost by a lack of comprehension of the facts regarding water-supply, as well as through "scheme" promoters, still the average value per irrigated acre, according to the census of 1890, was something over $83.

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* *Engineering News*, April 6, 1893. † U. S. Senate Ex. Doc. 41, part ii., p. 36.

On account of the continuous and disastrous failures of the dry farming lottery in the west, State, Inter-State, and national conventions have brought into consideration the possible methods of developing water-supplies for agriculture. Now, if by any manipulation of the water-supply, or by the adoption of any different policy or method of procuring or conserving water, the area irrigable can be increased 50 per cent., the result would be an additional irrigable area of 50,000,000 acres, which, at the average value in 1890, would be worth over $4,000,000,000. Again, if from a better understanding of the water-supply and the best methods of utilizing it millions of acres may be made more readily irrigable by the individual farmer, independent of any monopoly or bonded syndicate, a more ready development and a more satisfactory condition of community interests must result.

Major Powell is authority for the statement that in general the less the rainfall the less the percentage that runs off (stream measurements), and that, where the mean rainfall is 20 in. per annum, the mean run-off is 2 in. as measured in the surface flow of the streams. What, then, becomes of the other 18 in.? Can it be recovered, and, if so, how?

It seems evident that any man who thinks must be reasonably sure that, when the amount of water contained in a well or other hole in the ground is pumped out, one of two things must happen,—the well must remain empty, or the underflow must flow; also that, when a river in a dry season increases in volume as it flows, some other agency than the evaporation from its surface must be the source of supply which causes such increase; also that flowing springs, known nearly everywhere as the most reliable furnishers of water, unless they be supplied by flow through sands or gravel, must be continually sloping holes with no upper ends,—an absurdity indeed.

Having been employed as expert in a law suit involving the question of possible permanent supply by wells in a certain valley; having also been employed to design a gravity system to utilize the entire underflow of one of the large plains rivers; and having devoted 2 years entirely to the study of water-supply for irrigation development,—the writer has made several hundred tests of well-infiltration and flow of water in sands and gravels (coarse and fine, and various combinations of them), with slopes ranging from 3 ft. to 350 ft. per mile. To give the details of these tests with resultant curve diagrams, formulæ, and explanations, would require a long paper; moreover, the writer desires to complete at least one thousand tests before publishing the results. It is not the purpose of this article to anticipate and answer all the questions that might be asked regarding underground water-supplies, or to suggest the writer's ability to do so, but simply to present the following general conclusions resulting from his study.

The only source of the underflow is the rainfall, though geological conditions may be such that rainfall in one drainage basin furnishes underflow in another, and helps to supply another stream. The bed of a mountain stream, like the Arkansas or the Rio Grande, may have a continuous underflow from mountains to ocean; but the water that starts in the underflow at the mountains seldom, if ever, traverses the entire distance to the ocean, or any considerable part of it, generally reaching the surface of the stream by gravity, and then being evaporated. Underflow of the same level as the stream water, or nearly so, is limited to the width of the valley proper generally, but not always,—depending upon geological features. In general, the surface of the underflow tends to follow the ground surface, being higher, but at greater depths, under the divides and sloping toward the rivers. If the water-bearing material in the valley bottom is not much coarser than that back from the river, the slope of the underflow may extend to the river; slopes in sand, of 30 ft. per mile and possibly much more, exist to the river banks, while in valleys underlaid with coarse gravels the transverse sections of the valley proper usually show a level, or nearly level, water surface. All underground waters in sands and gravels, unless caged in some geological seam or pocket, are in constant motion under the influence of gravity, generally from the divides to the valleys and down the valleys, but, in rare cases, where the divides are sand to depths below the river levels, the water movement is in a direction away from the nearest river ; in short, the water seeks lower levels by the most practicable route. The amount of water in saturated sands and gravels ranges from less than 20 to more than 40 per cent., the theoretical maximum per cent. held between spherical grains being 48. The percentage volume of water depends mostly upon the uniformity of coarseness of material. Fine sand, if free from silt, contains the same percentage of water as coarse sand, or even coarse gravel, the general shape of the grains being the same. Very fine and silted sands and clays hold high percentages of water, but do not readily give it up or pass it along. A coarse gravel holding 40 per cent. of water may be so mixed with finer gravel and sands as to contain only 20 per cent. of water. The percentages of water that may be drawn off by gravity or by pumping, from the sands or gravel, are not proportional to the percentages held in them. The coarser the material, the greater the percentage drainable, because fewer grains give less area of capillary surface ; but a portion is invariably held back from the flow by capillarity. The greater the uniformity of sizes of grains or pebbles, the greater the percentage drainable, and, the coarser and more uniform the material, the greater the drainage speed. In a given material the speeds of flow are nearly in proportion to the slopes in feet per mile. The flow in coarse gravel with a slope of 50 ft. per mile (for example) is several hundred times the flow in a medium fine sand with a slope of 5 ft. per mile.

Any statement to the effect that the underflow has no flow, or that its flow in general is at about a certain rate, without stating the conditions governing that rate, is worse than a waste of time, for its flow varies under well-defined laws and between the limits of quiescence and a lively current.

Some streams, dry most of the year in the upper part of their course, become perennial further down from the constant underflow from the highlands ; one stream, for example, in western Kansas, flowing in sand and falling 13 ft. per mile, was receiving last winter from the underflow, after a very dry *year*, 26 cu. ft. per second in a distance of 6 miles. Sands and soils above the saturated water level are wet by capillarity, and, when a well-borer brings up wet sand, he has not necessarily reached the water surface by several feet. The height of the capillary wetting depends upon the fineness and uniformity of the sand, but has no effect upon the flow of the water in the *saturated* sands and gravels below.

The supply that will percolate into a given well depends upon its depth, its diameter, and the coarseness of material delivering the water to the bottom of the well. In an unstratified and uniform material constant pumping from a well produces an inverted conical water surface around the well, which surface, after stopping the pumps, returns to practically the original water level in from 1 hour to 24 hours, —not instantly, as many reports indicate.

The supply that a given well or other gathering chamber, in a given valley, will furnish permanently depends, first, upon the rate of infiltration; second, upon the cross section of valley, the slope thereof, the character of the sands, and the consequent speed of flow; third, upon the extent and character of the drainage area.

Determinable currents do exist through material at bottom of wells, and, when well walls are laid loosely without cement, may, in favorable material, exist at or near the surface of the water. In general, the lower strata currents are many times stronger than the upper. The conclusions and findings of Mr. Follett, whom I may seem to have been attempting to "call down," as well as the conclusions and findings of the other government experts, are, in general, corroborated by my experiments. The trouble between their conclusions and the people is that the people, and in general the engineers, are not sufficiently posted on the laws of underground waterflow to talk advisedly thereon. While residents say that the underflow is inexhaustible, the expert says it is not; and upon these grounds they stand, fighting a French duel, with a common cause at heart and both of them right. The underflow is exhaustible or not exhaustible, according to the means employed and the intelligence exercised in connection therewith.

The underflow of some streams or valleys is but a fraction of 1 per cent. of the surface flood flow. The average annual underflow passing a given point is seldom, if ever (owing to evaporation), equal to the average annual surface flow. The dry-weather underflow often exceeds the rainy-season underflow, and often exceeds the dry-weather surface flow very materially, for in the west the latter often becomes nothing. The underflow of any stream or valley is far more reliable and constant than the surface flow, and the writer's study has made him an optimist regarding the underflow for irrigation.

Gravity plants can be put in,—good for 80 or 100 years,—with no annual expense for maintenance or operation, that will deliver at the surface a steady flow the year round at a first cost of from $5 to $25 for 1 acre ft. every year. Thousands of (generally small) pumping plants can be put in at from $5 to $10 an acre, with an additional annual expense for repairs, fuel, etc. The former is the corporate or community plant, the latter the individual plant. Either plan must be carried out with a thorough understanding of all the conditions. Too many canals are being built where the reliable supply is not a canal supply. Too many pumps are being put in that are not best adapted to the work to which they are assigned. Gravity systems properly designed furnish from the immense reservoirs provided by nature the most reliable water-supply obtainable, and in this manner may be utilized at least a good share of the large and immediate run-off that is lost to view before reaching the stream gages of the government.

Throughout arid America, in which it is proposed that two hundred million people shall be prosperous on irrigated farms, the wealth of this coming empire is in the water, while sun and wind and the resulting evaporation are the robbers who would stimulate maximum plant growth, and at the same time take from the face of the country the plant blood necessary for such growth. The great problem of the west then is to conserve water-supplies against evaporation,—which averages from 4 to 10 ft. per annum, depending upon locality, and which reaches a frequent maximum of at least 1 in. a day and a rare maximum, in hot winds, of at least 1 ft. a day. These figures represent the amount of evaporation where the water is in sight. If the robber fails to find so much, he takes only what he finds. The failure to find any flow over the rock-bed of the Rio Grande at El Paso, Texas, is certainly no basis for the opinion that there is no underflow at Albuquerque, New Mexico.

The mean surface flow of the Rio Grande at Del Norte, Colorado, is 0.80 second feet per square mile drained. At Embudo, New Mexico, it is 0.20, and at El Paso, Texas, 0.06; or, in another light, the annual flow above ground at Del Norte (drainage area, 1,000,000 acres), at Embudo (5,000,000 acres), and at El Paso (20,000,000 acres) is practically the same, being generally from a half million to a million acre feet, equivalent at the latter place to a run-off of only (say) ½ in. annual rainfall. Excepting the mountain floods of April, May, and June, practically no water reaches El Paso, the light rains being evaporated from the face of the country, and the heavier local rains, along with the great share of the snow waters, going into the underflow to be gradually evaporated.

There are at least three possible methods of conserving waters in such cases. An international dam may be built at El Paso costing $1,000,000,[*] and empounding early each summer 500,000 acre ft., having an average depth of 23 ft., thus utilizing, possibly, 5 per cent. of the rainfall of the Rio Grande basin; smaller dams may be built in the mountains to supply local canals; and thirdly (upon which I wish to lay stress) nature may continue to store in the sands and gravels of the valleys as she has done for centuries, and the individual farmer may pump from under his valley farm, and the corporation may develop underflow gravity supplies, nature replenishing the supply, in either case, once a year.

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[*] Tenth Annual Report U. S. Geol. Survey, p. 145.

At least two thousand individual pumps, operated by wind, steam, and gasoline power, in western Kansas alone, are successfully and profitably watering farms (many of which had been abandoned by previous owners) from the underflow found at depths of from 10 to 150 ft. below the surface. The pump system of water-supply must become more popular as its good points become more appreciated. There are canals in the Arkansas and other valleys that are dry during the critical part of the summer season, because the streams are then dry. Intelligent gravity development will give them a summer flow or an all-the-year flow, as desired, within reasonable limits of expense, but such plants must be designed with a thorough understanding of the underlying material and the water-supply and its movements. Some of the gravity developments, as well as pumps, now in use, while considered successful, are faulty in design, and therefore more costly than they should be. To make a long story short, nature has provided immense storage reservoirs to which, at least on the great plains, no artificial storage can approach either as to capacity or freedom from evaporation. The beds of the streams are the safety-valves through which the surplus escapes to be evaporated or to flow to the sea. The more these features become understood, and the more individual pumps are put in to keep the water-level of the valleys down below the level of the river beds and away from evaporative influences, the greater will be the available water-supply. In other words, nature will help them who help themselves upon her plans.

A thousand city water-supply pumps and many thousand pumps for irrigation and other purposes, and a number of gravity conduits, are realizing, from the underflow, steady, reliable supplies of from 1,000,000 to 30,000,000 gallons per day, and developments along this line, in the writer's opinion, have scarcely begun.

RACIAL TRAITS IN MACHINE DESIGNING.

By Albert Williams, Jr.

IT is noteworthy that, notwithstanding the present closeness of intercourse between engineers the world over, through published accounts of machines and structures, in books, technical journals, and the proceedings of engineering societies, and by travel and personal inspection, there should still exist such wide variations in method in different countries. This is the more remarkable in view of the consensus of opinion as to underlying principles in almost all cases, and the fact that there are in many instances well-recognized standards.

Methods of course vary considerably in the same neighborhood; but it is a curious study to trace the manner in which racial peculiarities and environment show themselves in machine designing, in spite of the growing admixture of nationalities by the transference of engineers and artisans from one country to another, the availability of similar materials, and competition in the same markets. An examination of this kind is not merely a pastime professionally, but may have some practical utility, if it enables us to take broader views, to lay aside local prejudices, and to copy good features and avoid repeating bad ones, in looking over the whole range of construction as practised in different countries.

There are two main considerations in planning any machine, structure, or tool,—utility and economy. Under the former head the designer would place first effectiveness in operation; then the special or general applicability of the thing to be made, its durability, and its facility of construction. Under the second head he would have to consider the first cost, the running expense, the maintenance, and repairs. Then there is one more point, not always or perhaps even generally considered,—namely, the appearance of the machine, tool, or structure. This is by no means unimportant, for, besides its purely esthetic bearing, it certainly influences the adoption and sale. So long as the securing of a pleasing appearance does not antagonize any of the more important essentials, why should not the visual effect be taken into account? Here is ample scope for individuality. What is good taste? What effect have convention, habit, change of fashion, resemblance to popular models of other kinds? As to these questions no two persons precisely agree, but, when larger groups, such as whole nations or races, are considered, some broad differentiations can be traced.

It is safe to say that one who has given any attention to the subject, on looking at a new machine, implement, or tool, can make a tolerable guess as to its source without examining the trade mark or stamp of the maker's name and place of manufacture. Each bears upon it a certain individuality (unless it happens to be a mere copy, and even then a closer inspection might detect small changes), just as each human face has its own stamp. Could anything be more thoroughly British than the English "goods engine"? Where it is hard to particularize exactly, it is still possible to localize it within certain broad limits. After looking over the examples in any one mechanical department of a great international exhibition, a general idea of the field is obtained, so that, if the machines or tools of several groups were presented intermingled, the observer would be enabled to place them approximately, without referring to labels and stamps. Opportunities for simultaneous comparison on a wide scale, as offered by such exhibitions, are not given to all, or at all seasons, though becoming more frequent. But, without them, all have access to published descriptions and working drawings and pictures, and those who use their eyes—who see as well as look—may find much that is instructive presented all the time and without going out of their way to seek it. The everyday observer acquires the faculty of identifying, in more or less degree, until it becomes unconscious and instinctive, in somewhat the same manner that one roughly rates dimensions, weights, and proportions at a glance, without conscious calculation. The custom-house inspectors and patent-office examiners could supply some interesting testimony on this score.

Perhaps it would not be altogether profitless to inquire, given a certain engineering problem, how would a French, a German, an English engineer go about it? How would the habit of thought, the training, the experience, the natural bent, of each influence him in choosing his mode of solution, if there is more than one, and how would each work out the details? Surely it would not be useless to accustom oneself to look at things through the eyes of others, to place oneself at their mental standpoints, to avail oneself of the multifold experience gained under varying conditions, and still more to habituate oneself to laying aside, so far as possible, the personal prejudices depending on temperament. As an actual fact, this is what the engineering world is gradually approaching. Narrowness of ideas is giving way to a study of wide ranges of method and a willingness to adopt foreign systems, if they are better,—not as a servile imitation, but intelligently and consistently with modified conditions. But the tendency has by no means gone so far as to wipe out or much obscure these racial peculiarities of construction.

According to accepted notions of racial characters, the English and Scotch are proverbially conservative, methodical, painstaking, and careful to secure durability by using sound material and often an unnecessary surplus of it, making safety a high factor. Their predilection for rigidity, leading to heavy frames and bed plates, sometimes goes to cumbrous extremes. They have not got over a partiality for hand work where special excellence is desired. Their machines are, as a rule, very reliable. Little attention is given to appearance and finish, and the machines have an extremely businesslike look, to the American eye overponderous and somewhat clumsy, the idea of construction suited to a great forging hammer or shears being repeated in smaller, fast-running machinery where it seems out of place. Like their machines, their bridgework and other engineering structures are very substantial. A characteristic instance is the choice of the cantilever where a lighter suspension bridge with stiffening truss would suffice. They have not gone very far in adopting interchangeability of parts and close template and gage adjustments, so that many of their machines are turned out as individuals which could be built in multiplicate, with corresponding loss of time under the prevailing system. In the export trade—always excepting the "Brummagem" goods—they have striven for a reputation for reliability, so that for some articles, such as hand tools and cutlery, a position was gained which is not undisputed by rivals at the present.

The French are quick, sensitive, innately artistic in all their perceptions, particular as to details and finish, and somewhat given to an inordinate desire for originality of effect leading sometimes to *bizarre* designs; their products, however "showy," are never absolutely unsightly. Attention is given to the appearance of tools and implements intended for the simplest and most homely purposes. Hand work is preferred to machine work, partly because it is cheap enough to compete with the machine tool, and partly because of the abundant supply of intelligent, skilled artisans in the lower grades.

The German designer, always well grounded in mathematics, calculates stresses and proportions minutely, but in the outcome does not shave so closely as the Yankee. He never allows himself to be hurried, and, in everything made for the home market, is conscientious. In the proportioning of parts with an eye for effect, he produces curved lines and rounded masses, reminding one of the drawing of the old Flemish and German artists, and which somehow fail to convey the idea of precision given by sharp, angular contours.

The Belgians have latterly become great fabricators of heavy metal work, and, as their low prices make them dangerous competitors, their rivals affect to impugn the excellence of material and workmanship. In certain lines of hand-made implements and firearms of the cheaper grades they have long been prominent. The appearance of their machines, architectural ironwork, etc., resembles German rather than French models.

The Swiss have developed astonishing manual dexterity and the versatility required in making all, or nearly all, the parts of such a machine as a clock or a watch by one person ; but recently, driven by competition to adopt machine work in factories, instead of isolated hand work, division of labor, interchangeability, etc., their system has been changing—to the detriment of individual skill, but to the benefit of the mechanical industries as a whole. As the kinds of machines and tools made at home are limited, they have acquired a marked individuality, difficult to describe, somewhat resembling French types. The wood carvings and hand-made woodenware for the export trade always seem to have a freshness of design, no matter how often repeated ; but their cheaper watch movements, resembling the American ones of the same grade, are rather deficient in precision.

The Austrians, and the South Germans generally, turn out work resembling that of the North Germans, but showing less progress. The exports (to semi-civilized lands especially) are characterized by cheapness.

The Italian and Spanish designers have a tendency to retain medieval and renaissance traditions, both as to form and decoration, not only in such manufactures as weapons, but even, incongruously sometimes, in articles of strictly modern invention. Spain and Portugal are very backward in mechanical contrivances, depending upon foreign supplies. Italy, on account of her great military and naval equipment, has been forced to make progress in the line of heavy machinery, but even here she is not altogether independent.

Passing by other nationalities, which either use practically no machinery, or (like Norway and Sweden, Holland, Denmark, and Russia) do not offer striking examples, or (like the British colonies and India) follow English practice, slightly modified, or (like Spanish America) are dependent on Europe and the United States, we come to China and Japan. Neither country until lately made any machinery, though both exported some mechanical goods,—the Japanese cutlery and swords being of notable merit. Military requirements in both countries led to the establishment of great arsenals for the making of war material, and these were built and operated under English and German supervision, so that methods were mere copies. Japan, however, is becoming independent of foreign engineers, and will soon establish an individuality of its own, and one of no low order.

On first thought one would expect the work of the American designer to closely resemble that of his English kinsman, or to be of a composite type, resulting from the race admixture. Yet it is neither the one or the other, but of marked individuality. We have not discovered the much talked-of "American style" of architecture, unless the tall steel-frame office building with its veneering marks an epoch in "style" as well as construction; but a new line of mechanical progress has been struck out in the United States. The causes are not far to seek and are well known. The requirements of a new and rapidly developing country naturally evolved the men and the means. The earlier demands for inland transportation brought out new types of locomotives and engines for river and lake steamers, while special attention was given to designing agricultural implements and mining machinery, in all of which entirely new methods were introduced. In the intermediate stage our specialties were light machinery, sewing machines, firearms, timepieces, "Yankee notions," etc.; but at present there is no limit to the variety, and the greatest advances have been made in the heaviest machinery, marine engines, pumping engines, mill engines, electrical plant, etc., until practically nothing in the mechanical line is omitted that is made elsewhere.

The American regards time and money as of the first importance. Labor is dearer than abroad, and, while there is a large stock of inventive genius, there has been relatively a dearth of skilled operatives of the lower ranks,—plenty of good foremen and men competent to manage complicated machinery, but few who (at the wages) could take the place of the machines. Hence we find a preponderance of labor-saving devices, machinery supplanting handwork in unexpected directions, for making and even assembling interchangeable parts, for handling materials and products,—a strict division of labor (of which the watch-making and shoemaking industries are good examples) with the final result that American artisans turn out more work per capita than average workmen elsewhere, so that the employer can afford higher wages, whether for day or piece work, and can generally select his operatives.

American peculiarities are strongly marked. The best ones are directness of design, by which is meant the shortest cut to reach a given end, the designer having in mind the thing to be done quite as much as the machine which is to do it; lightness and a close proportioning of parts; in machine work a near approximation to pattern; rapidity of construction and rapidity of action in the finished machine; the substitution of special steels and new alloys, hollow construction, etc., for older materials and construction; and a generally neat appearance of work, with burrs, lips, and roughness of casting removed. The American designer is not an artist, like the Frenchman, but is more attentive to appearances than the Briton. He is gradually curing himself of the tendency to tawdry ornament, needless accessories of fancy castings, stenciled paints, japanning out of place, bright work for mere effect, etc. We are not an esthetic people, whatever we may pretend to others and to ourselves; other people take pains to inform us of the fact, so there must be something in it. The worst fault the American designer is accused of by the English competitor is a skimping of material down to the lowest notch. This is not, as a rule, deserved; yet there have been enough instances to give occasion to the charge. The accusation of using inferior material is not sustained; but certainly an American machine is seldom too expensive for its purpose, the idea being to hit the requirement safely and then not to overshoot it. On the contrary, the first cost of the machine may seem extravagant, but is justified if that will make it more rapid in operation or diminish the need of attendance. Probably, on the whole, American machinery is less lasting than English. If it serves its purpose, and meets the profit and loss question, that is enough.

Single machines and tools having a multiplicity of functions are a hobby with the American designer and inventor. The Yankee combination jack-knife and tool chest is a famous example, on the small scale. If you look over the patent gazette you will find many such things as combined reapers and binders, perfecting printing presses, universal milling tools, wood and metal lathes, channeling and drilling machines, etc.,—perhaps even combined knitting machines and baby jumpers, or pile-drivers and spice mills.

Another striking feature is the variety of single machines designed to perform a large number of similar acts at the same time, such as the multiple boring and sawing tools. This gives rise to a complexity of parts, but avoids the duplicating of main frames, beds and driving attachments, and single adjustments. In most cases it will be found to require higher skill to make, adjust, and repair American machines, with less need of supervision when once in working order; that is, some of the brain power put into their construction is saved at the other end in operation. This is not always so, delicately adjusted machines often requiring highly-trained supervision and feeding to give the intended results.

The triumph of the American inventive faculty is in those machines called "automatic," some of which are as nearly so as can well be imagined,—steam engine cut-offs, governors, and regulators, self-feeders and self-dischargers of many kinds, automatic belt elevators, conveyors, double inclined planes, aerial ropeways, and so on.

Much has been said as to the daring of the American inventor and designer, and with considerable truth. Sometimes he carries it too far, with disastrous results to himself and to his backers; but such failures are not without their compensations to the world at large. If all were timid, or merely conservative, there would be little progress. Originality, it must be observed, is not the exclusive property of American designers by any means. On the contrary, the greatest discoveries in physics and mechanics on which modern machine construction is based have been, for the most part, due to Europeans, as would naturally be expected, in view of the greater amount of experimental research by foreign scientists. But in the first steps toward the application of great discoveries, in the constructive details which render them practically available, Americans have taken a leading position. So also in the early inception of many groups of machines, the first actually operative examples have been brought out in the United States. The original idea of the feasibility of doing a certain thing may have been had by many, and in the crude state may have been useless, until the man appeared who could produce a machine that would "work." Very few of the so-called inventions of the highest class were really invented by one person; most of them were the outcome of many minds. But it is unfair to detract from the merit of the mechanical genius who first brought them into use, by saying, as may be perfectly true, that the idea was an old one. It is the working out of mechanical details, the combining of well-known principles with the proper mechanism, in which merit consists; and this often means striking novelty in the adaptation of parts and motions.

In considering the influence of race characteristics upon the mind of the designer, the doctrine of evolution by natural causes and reactions supplies much light. The character of the country, its size, topography, climate, resources, density of population, and many other things go to form the mental habits of the people. An insular position, inadequate food supplies, large population dependent on manufactures, great coal deposits, and innate energy could not fail to turn the attention of the early English and Scotch engineers to the development of the steam engine, marine engineering and naval architecture, textile machinery, etc., and the necessities of the case have made their works, as already stated, eminently businesslike, with little attention to matters of taste and the British practice of to-day upon the same things. On the continent of Europe the mere question of latitude and consequent climate has stamped certain characters upon the several nationalities, which not only are reflected upon their arts and in their habits of life and modes of thought, but may be found repeated even in the machines, and implements which they severally make and use.

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Bankers Mag. of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6*s.* London.
Boston Jour. of Commerce. *w.* $3. Boston.
Brick Builder. *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bul. Am. Geog. Soc. *q.* $5. N. Y.
Bul. Am. Iron and St. Asso. *w.* $4. Phila.
Bul. of the Univ. of Wisconsin.
Calif. Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Rev. *m.* $1.50. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan. *m.* $2. Meadville, Pa.
Chem. Trade Jour. *w.* 12*s.* 6*d.* Manchester.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Contemporary Review. *m.* $4.50. London.
Cosmopolitan. *m.* $1.50. New York.
Domestic Engineering. *m.* $2. Chicago.
Electric Power. *m.* $2. N. Y.
Electric Railway Gazette. *w.* $3. N. Y.
Electrical Age. *w.* $3. New York.
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York.

Electrical Engineering. *m.* $1. Chicago.
Electrical Industries. *m.* $1. Chicago.
Electrical Journal. San Fancisco.
Electrical Plant. *m.* 6*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Engineer. *s-m.* $2.50. New York.
Engineer. *w.* 36*s.* London.
Engineer & Contractor. *w.* $1. San Francisco.
Engineering. *w.* 36*s.* London.
Eng. and Mining Journal. *w.* $5. N. Y
Engineering Magazine. *m.* $3. New York.
Engineering Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
Eng. So. of W. Pa. Proc. *m.* $7. Pittsburg.
Fairplay. *w.* 32*s.* 6*d.* London.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J.
Fortnightly Review. *m.* $4.50. London.
Forum. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engrs' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World. *w.* 13*s.* London.
Geol. Mag., The. *m.* 18s. London.
Heating and Ventilation. *m.* $1. N. Y.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Industry. *m.* $2. San Francisco.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age. *w.* $4.50. New York.
Iron and Coal Trades. *w.* 30*s.* 4*d.* London.
Iron & Steel Trades' Jour. *w.* 25*s.* London.
Iron Ind. Gazette. *m.* $1.50. Buffalo.
Iron Trade Review. *w.* $3. Cleveland.
Jour. Am. Chem. So. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Jour. Assoc. Eng. Soc. *m.* $3. St. Louis.
Jour. Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. As. *q.* $2. New London.
Jour. Polit. Economy. *q.* $3. Chicago.
Jour. of Royal Inst. of Brit. Arch. *s-q.* 6*s.* London.
Journal of the So. of Arts. *w.* London.
Locomotive Engineering. *m.* $2. N. Y.
Lord's Magazine. *m.* $1. Boston.
Machinery. *m.* 50 cts. N. Y.
Machinery. *m.* 9*s.* London.
Manufacturer and Builder. *m.* $1.50. N. Y.
Manufacturer's Record. *w.* $4. Baltimore
Marine Engineer. *m.* 7*s.* 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Mag. *m.* $1. N. Y
Mechanical World. *w.* 8*s.* 8*d.* London.
Metal Worker. *w.* $2. N. Y.
Milling. *m.* $2. Chicago.
Min. and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver
Mining Jour, The. *w.* £1. 8*s.* London.
Mining World, The. *w.* 21*s.* London.
National Builder. *m.* $3. Chicago.
National Car Builder. *m.* $2. New York.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. N. Y.
Nineteenth Century. *m.* $4.50. London.
North American Review. *m.* $5. N. Y.
Paving & Mun. Eng. *m.* $2. Indianapolis.
Plumber and Decor. *m.* 6*s.* 6*d.* London.
Popular Science Monthly. *m.* $5. N. Y.
Power. *m.* $1. N. Y.
Practical Engineer. *w.* 10*s.* London.
Procd. Engineer's Club. *q.* $2. Phila.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. N. Y.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway Times, The. £1. 5*s.* London.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York.
Rhodes' Jour of Banking. *m.* $5. N. Y.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. N. Y.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. N. Y.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
Social Economist. *m.* $2. N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn.
Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. N. Y.
Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
Trans. of the Wis. Acad. Madison.
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.

ARCHITECTURE & BUILDING

The Late Richard Morris Hunt.

Not only the architectural papers, but also other technical papers and the daily press, have joined in paying respect to the memory of one of the most successful American architects within the memory of the present generation. When a man like the late Richard Morris Hunt dies, a man whose influence beneficially pervaded the entire profession to which he belonged,—a profession honored by his membership—it is fitting that his virtues and talents should be recorded that those who follow may profit by so conspicuously bright an example.

The best account of the life and labors of Richard Morris Hunt which we have yet seen is a five-column article written by Mr. P. B. Wight in the *Inland Architect and News Record* for August. Of this excellent biographical sketch we shall endeavor to make an abstract which, though brief, may give our readers some idea of the career of this typical American.

Mr. Hunt was born at Brattleboro, Vermont, October 31, 1828. His father, Jonathan Hunt, was descended from a long line of New England ancestors, and from 1827 to 1832 was a member of congress. His mother was Jane Maria Leavitt. His older brother, William Morris Hunt, who died in 1879, was one of the most brilliant artists America has produced,—a painter imaginative in the highest degree, as well as a sculptor. His father died while he was still a youth, and his mother, who was a woman of high intellectual attainments, undertook the education of the children, which became the aim and study of her life, and for which fortunately she possessed the means. She moved to New Haven for this purpose. Here the boy Richard Morris attended a school of high character, and afterward he graduated from the Boston Latin school. In 1843 his family removed to Geneva, Switzerland. Mr. Hunt studied drawing and architecture about 5 years in the studio of Samuel Darier. After the organization of the American Institute of Architects, Mr. Darier was nominated by his old pupil for honorary membership, and was elected. In 1848 Mr. Hunt went to Paris and commenced a course of architecture at the École des Beaux Arts, and also became an *élève* in the *atelier* of Hector Martin Lefuel. During his residence in Paris he travelled much in Europe, Asia Minor, and Africa. In 1854, through the influence of Lefuel, he was assigned by the government to the supervision of the Pavilion de la Bibliothèque. In this work he not only carried out the designs of Lefuel, but is credited with having personally worked out many of the details. He also had at this time many great French architects of the period as associates.

In 1855 he returned to America, and here began a phenomenally successful career. At first he established an *atelier* and took pupils. Almost the first practical work he did involved him in the suit—now historical—of Hunt vs. Parmly.

Dr. Parmly, a wealthy and distinguished dentist of New York, erected two expensive houses on Thirty-seventh street, which were unmistakably built from designs by Hunt. No one else could have designed them, and certainly no one who had graduated only from a carpenter's shop. But Dr. Parmly, sustained by his "practical" builder and superintendent, insisted that he had never employed Hunt, and did not erect the buildings from his plans. Hunt sued, and astonished the court by the great pile of working drawings produced, all of which had been used on the building. But the jury rendered its verdict under Dogberry's "Crowner's quest law," and the case was lost. But it was of immense benefit to the profession in New York. It put all architects on their guard in making engagements with their clients, and helped to establish a uniform system of charges by percentage.

Best of all for Mr. Hunt, it brought him to the notice of the most intelligent class of wealthy New Yorkers, and thenceforth his success was assured.

We cannot follow the story through all the steps which led to renown, but will content ourselves by such indications of its extent and completeness as are indicated in the following paragraph :

"The following is believed to be a correct list of the titles and honors accorded to Mr. Hunt during his extensive career: president of the New York Chapter of the American Institute of Architects, 1868 to 1887 ; president of the American Institute of Architects, 1887 to 1891 ; president of the Board of Architects, World's Columbian Exposition, 1891 ; doctor of laws, Harvard University, 1892 ; president of the Municipal Art Society, New York, 1893 ; honorary member of the Architects' and Engineers' Society, of Vienna ; member of the Society of St. Luke, Rome, Italy (said to be the oldest society of architects in the world) ; honorary corresponding member of the Royal Institute of British Architects ; recipient of the royal gold medal of the Royal Institute of British Architects, June 19, 1893 ; member of the Central Society of French Architects ; Chevalier of the Legion of Honor, 1882 ; corresponding member of the Academy of Fine Arts of France, in which, the number being limited, he took the seat of M. Matejco, a Pole. He regarded this as the highest distinction that had been conferred upon him. But the reception of the royal gold medal was a compliment as well to American architecture, of which he was a worthy representative. The highest honors in this country were the presidency of the American Institute of Architects, and the degree of LL. D. from Harvard University. A partial list of his works follows :

"The Parmly house, Thirty-seventh street, New York ; dwellings on Park avenue, near Thirty-fifth street, New York ; the Tenth Street Studio Building, the Lenox Library, the first buildings of the Presbyterian Hospital, the Coal and Iron Exchange, New York *Tribune* Building, Hotel Victoria, residences of C. O. D. Iselin and Henry Marquand, and the Marquand office-building on lower Broadway, all in New York ; residences for Marshall Field and William Borden, Chicago ; residence for William K. Vanderbilt, New York ; the Yorktown Monument ; pedestal for the statue of Liberty, New York Harbor ; Soldiers' and Sailors' Monument, Portland, Maine ; Vanderbilt Mausoleum, New Dorp, Staten Island ; Theological Library and Marquand Chapel, Princeton, N. J. ; Divinity School, Yale College ; Gymnasium and Recitation Building for the United States Military Academy, West Point ; Naval Observatory, Washington ; Scroll and Key Club House, New Haven ; Martin Brimmer's houses, Boston ; George Vanderbilt's residence, "Biltmore," at Asheville, North Carolina ; and at Newport his own cottage and those of the late Charlotte Cushman and the late Richard Baker, the 'Marble Palace' now owned by Mrs. Alva Vanderbilt, the residence of Ogden Goelet, and 'The Breakers,' his latest work for Cornelius Vanderbilt. Lastly may be mentioned the Administration Building at the World's Columbian Exposition."

This last was his most original work, and Mr. Wight calls it "the grandest monumental design ever made by an American." The author closes his article with the following feeling and well-deserved tribute to Mr. Hunt's character and professional skill and personal influence.

"As a man he had all the elements of greatness. His was the master mind, when brought in contact with others. He was serious or jovial, as occasion required. Like Yorick, 'he was wont to set the table in a roar.' He always had a ready story 'to point a moral or adorn a tale.' His language was quaint and original, but always forcible. He was totally unaffected, and was at home with 'all manner of men.' He was always ready to help the weak, and no enemy had any terrors for him. His whole life, teaching, and example had more influence than that of any other half dozen men in establishing a high standard of professional honor, and gave a dignity to the profession of architecture in America of which it was sadly deficient 50 years ago."

Foundations of the Cathedral of St. John the Divine.

THE building of this cathedral is probably the most important architectural work now in progress in the United States. When it is completed, there will be few larger, and, let us hope, handsomer and more costly ecclesiastical buildings in the world. *The Engineering Record* (Aug. 10), in describing the foundation work and some unexpected difficulties encountered in its execution, says the "finished building will be about 520×290 ft. in extreme dimension (about as large as St. Paul's in London), and will have a grand tower 445 ft. high. At present the construction is begun only upon a small part of the edifice, —*viz.*, upon the tower and its adjacent choir, for which the foundations are now well advanced.

"As the rock outcropped in places at the site, it was believed that solid and most satisfactory foundations would be very easily secured, but, when excavation and leveling was begun, it developed a singular and troublesome condition of affairs, which has necessitated much delay and expense. The stone—the familiar gneiss of the locality—was disposed in very irregular masses, the formation of which was almost like waves, the surfaces of the outcropping ledges sloping down in places at a sharp angle and intersecting at the vortex of troughs 20 to 45 ft. below the surface. At other places the surface of the solid rock was not so deep, but was very irregular, and much of the upper part of the stone was found loose and disintegrated or filled with pockets of earth and clay, so that considerable excavation was necessary to secure an enduring and reliable platform on which to impose the heavy and extensive loads of the enduring structure."

Pits for piers were therefore excavated and filled with concrete to an average depth of 15 ft. The most scrupulous care was taken to thoroughly clean the rock faces of pit walls, in order that the cementing of the concrete to the natural rock should be perfect. "The foundations will contain about 5000 cu. yds. of dimensioned granite masonry. Sooysmith mixing machines are used in making the concrete." Each mixer is set with the top hopper about level with a working platform that closely surrounds it at the surface of the surrounding ground, and upon which materials are delivered by wheelbarrow and derrick and placed in bins. Men with shovels keep it continuously fed into chutes that carry it down to a platform about 6 ft. below, upon which rest the lower ends of three inclined chain and bucket conveyor elevators that are driven at the same speed—about 2 ft. per second —by a small vertical engine on the same platform. This engine also drives the mixer. All are driven by belts which will slip and allow the machinery to stop when obstructed rather than break as a gear would. One elevator is encased throughout in a tight wooden case, the lower part of which is filled with loose cement, which it brings up and empties into the upper part of the mixer hopper. The next elevator is on the opposite side of the hopper, a couple of feet nearer the discharge end, and delivers sand from a heap at the foot of the chute below, where two men are constantly in attendance to see that each bucket is level full. The third elevator is 2 ft. further away on the same side as the cement elevator, is similarly served by two men, and delivers gravel. The mixer is about 12 ft. long over all, and inclined about 1 in 12 down towards the discharge end. Its shaft makes about 20 revolutions per minute, and is fitted with about sixty inclined beveled radial cast-iron arms that mix the materials very thoroughly, even before they are wet by a man with a hose nozzle just opposite the gravel elevator, and considerably more afterwards. The elevator buckets each hold about 1 cu. ft., and discharge their contents over to the further side of the shaft. They are set at distances apart on their chains inversely corresponding to the proportionate quantities of material they are to furnish for the concrete. Below the mouth of the mixer is a third and still lower platform, upon which are two short 30-in. gage tracks, about 4 ft. apart center to center, each with one car upon it. A car upon one of these tracks is run up under the mouth of the mixer and a little to one side of its axis, but parallel with it, and the mixer delivers continuously into its 1-yd. iron bucket (which it can fill heaping full in a minimum time of about 2 minutes) by a flat wooden chute 4 ft. wide and 6 ft. long, mounted on a horizontal axis just below the mixer and in a vertical plane through its own axis. This chute is operated like a butterfly valve, first tipped up to the angle of 45 degrees with the vertical on one side, so as to divert the flow from the mixer all into the bucket on the right-hand car. When that is nearly filled, a bucket and car are pushed up on the left-hand track. The top of the chute is revolved 90 degrees to the right, and the discharge from the mixer is instantly diverted into the empty car, and the full one is run off and taken by the derrick, which can usually swing it to the required place and empty it immediately. Sometimes hauling and the delay of materials threaten to hinder the work, and such occasions are taken to lay concrete so remote from the mixers that it takes more time or the use of two derricks to handle it. When the concrete is set, it is kept constantly well sprinkled for several days.

Architecture in London.

THAT Americans know little of architecture in London; that architecturally it is an undiscovered country; that the buildings of historical interest usually visited by tourists in London have often very small architectural value; that the present attempt by many architects "to subject us to the domination of the French" has caused the claims of current architecture in England for consideration "to be almost ignored, if not altogether overlooked"; and that there is bad taste "in neglecting work of a people from whom our ancestors descended, who speak the same language," and "who in race stand closer to us than any other,"—are charges made by Mr. Barr Ferree in *The Architectural Record* for July–Sept.

While Mr. Ferree admits that England has architecturally suffered from a variety of causes, and that even now it suffers "from a unity of purpose among its architects, from the rapid changes in the popular taste of the day, from the importation of foreign styles for a few years only, to be cast aside for something in a later fashion," yet he does England the justice to say that in that country "there has been an incredible spread of correct architectural taste, of sound artistic feeling, of a striving after better things, of an effort to renew the historical continuity that was broken in the last century."

Mr. Ferree has been considered by some rather too much of a fault-finder, but, whether this is a fair criticism or not, in this instance it is the good, not the bad, in English architecture to which he says our attention should be directed. Notwithstanding, one of the first examples of London architecture which he mentions is a specimen of the superlatively bad. After stating that "the most interesting structures in London are of very recent date," he says of Queen Anne's Mansions that though "not so old as many of the dull streets of London, they are an excellent type of this style of building; a huge group of structures ten or eleven stories high, without a single architectural idea; a monstrous pile of negation that in self-asserting commercialism, profound indifference to architectural thought, complete disregard of architectural amenities, if so they may be called, quite exceeds all other structures of the world. It is customary to twit America—and the English are perhaps the loudest in so doing—with its subservience to commercialism in architecture; yet nowhere on the face of the globe can such a terrible example be seen as this pile of London flats. It is not a type; it is rather the culmination, the final expression, let us hope, of a system of building long before applied on a smaller scale, but in quite as horrifying a manner, to miles and miles of London streets." After some more of this, Mr. Ferree follows his own advice, and gives a series of illustrations and descriptions of the "good new buildings of London." For these, brick and terra cotta are the favorite materials.

"New brick of a brilliant red is much used, though how it will stand the effects of London climate I do not know. When new, it is a very good color indeed, and some happy combinations are obtained with trimmings of a light buff stone, almost white when fresh. Not so successful is a sort of pink terra cotta, an artificial mixture introduced by the manufacturers, and which seems to have 'caught on' without any reason for the catching. It speedily becomes faded and dirty, and is not in the least suited to London. When used alone, the effect is bad enough, but unfortunately it is often employed in combination with red brick, not unpleasing when new, and, in fact, rather startling, but excessively depressing after the pink has lost its freshness. The ease with which terra cotta adapts itself to ornamental and decorative purposes is as great a snare to London architects as it is to those in other parts of the world. Centuries of experience do not seem to have impressed the average London architect with the knowledge that the climate of his beloved city is entirely unsuited for elaborate external detail. Sooner or later detail in any material, in brick, in terra cotta, or in stone, blackens and darkens until its value is almost gone, or until what was intended as an ornament becomes a positive eyesore."

The illustrations include residences, landscape architecture, public buildings, and commercial and office buildings. A liitle, but that in high praise, is said in conclusion regarding modern London church architecture.

The Building Laws of Byzantium.

VERY early in the history of civilization it was found necessary to the safety of cities to regulate by law the construction of buildings. An interesting example of such regulation is found in the building laws of Byzantium, promulgated by the emperor Zeno in the latter part of the fifth century. Zeno's building laws commanded the admiration of Roman jurists. *The Architect* (July 13) gives an interesting epitome of this code, and an account of the circumstances under which it was put forth. Earthquakes were frequent and fires numerous. "Hordes of 'water thieves and land thieves' seemed to be always on the alert to seize everything of value which the city contained. The inhabitants, like weak animals, herded together, as if overcrowding were a source of strength. The city of London, in the old days before the Great Fire, did not present a more remarkable indifference to the laying out of streets or buildings for the common benefit. One of the Byzantine historians, who wrote in the early part of the fifth century, relates that the ground in Byzantium was insufficient for so many buildings, which were separated only by narrow lanes. Additional space could only be found by endeavoring to reclaim it from the sea by costly piling. The unfortunate inhabitants suffered equally within doors or without; they were either hampered through want of room in their dwellings, or jostled by the crowds in the close streets. When an earthquake occurs, wrote an eye-witness, the people rush out of their homes regardless of the cold or the darkness. But they find they are still in danger. The buildings are so lofty and so near each other, if they fall, great destruction of life must follow. Energetic emperors tried to cope with the evils of overcrowding, but in vain. The works for water supply and the public buildings might be remarkable, but they could not be considered as efficient remedies." When fires occurred, they were usually disastrous, owing to the overcrowding. Zeno strove to free his code of building laws as much as possible from technicalities, so that the common people, as well as the lawyers and judges, might comprehend their full import. In rebuilding and repairing no owner was allowed to change the character of a structure, and there was to be no greater interference with light and air than previously existed. A space of 12 ft. was decreed to be left between adjacent houses. Without such a space, the limit of height was 100 ft. This height was allowed in rebuilding after a fire and "in the case of houses on sites which were not used for buildings at an earlier time." But in all other cases of rebuilding the height of 100 ft. was permissible only when a space of 12 ft. was left between the new house and the houses next to it. For the sake of the wide space Zeno was willing to allow the prospect enjoyed by a neighbor to be diminished. In other cases where high houses were erected and the open space was not less than the normal 12 ft., the disturbance of prospect was allowable only with kitchens, passages, and staircases, which were the parts rarely used for the enjoyment of views. Restrictions and limitations were imposed upon the use of timber. Contractors who desired to evade their obligations had a bad time of it. "A contractor or workman was prohibited from abandoning work before its completion." If "the work were not completed by the time agreed, compensation had to be paid to the owner for all his losses, and apparently prospective damages also. Whenever a contractor was impecunious and unable to pay for the losses and other penalties for which he became liable, he was to be flogged and expelled from Byzantium. As in our time, it was supposed to be disloyal to the craft for a new contractor to take up the work which another had left incomplete. Zeno would give no sanction to an economical theory of that kind. According to the law, if a contractor took up the incomplete work, he was bound to bring it to completion, or to incur the same penalties, including scourging, as the original contractor."

Colored Bricks.

THE liability to production of inartistic effects in the use of colored bricks in inexperienced hands is editorially considered by R. C. S. in *The Brickbuilder* for July. The writer of this editorial is announced to be "an architect of the highest professional standing," and, as such, he ought to be able to speak to the point on this matter. As to the accurate smooth red brick laid up with a fine red joint, while it is entirely suitable for certain places and certain kinds of work, a too general use has been made of it, of which it was not worthy. The tendency is now to return to the common red brick, and this material is pronounced at once economical and safe. "While it can never offer the opportunities which varied colors give, it has, at least, varied shades of color, and that color which is first-rate for exterior work. The history of architecture gives ample authority for the general use of red brick. Of the various countries which are notable for their architecture, Italy, Holland, and England give us, perhaps, the best precedent for its use. In Italy we have the splendid remains of Roman brick-work and the later brick-work of the Renaissance period. In Holland we find whole cities built of brick,—houses, shops, warehouses, and even public buildings and churches; and in England it would be hard to find any more lovely and typical examples of what is good architecture than the old red brick houses such as are scattered throughout the land."

Notable buildings constructed of common red brick are Holland House, in London, the Tower of St. Albans, the Waag at Amsterdam, the church at Dordrecht, the church of the Frari at Venice, and Santa Maria's Tower in Rome; in the United States, the Virginian Westover, or the church at Alexandria.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Architecture and Building in the American, English and British Colonial Technical Journals—See Introductory.

*686. The Architectural Students' Work Abroad. G. R. Phene Spiers (Deals with methods of study, as exemplified by different eminent architects, and with opportunities for mental cultivation and development of powers of design). Eng Mag-Oct. 2800 w.

697. Faulty Fire Escapes. Ill. Owen B. Maginnis (Inutility of most fire escapes. Favors the balcony escape). Arch & Build-Aug. 10. 500 w.

710. The Mary Hitchcock Memorial Hospital, Hanover, N. H. Ill. Edward Cowles, in "Hospitals and Asylums of the World" (Descriptive). Am Arch-Aug. 10. 2800 w.

730. Construction of the Foundations of the Cathedral of St. John the Divine. Ill. (Descriptive). Eng Rec-Aug. 10. 2000 w.

*787. An Ordinance Providing for the Creation of the Office of Inspector of Buildings, of Atlanta, Ga., Fixing his Salary, Term of Office, Duties, etc. So Arch-Aug. 6000 w.

*788. A Bill to Regulate the Practice of Architecture in the State of Georgia. So Arch-Aug. 2200 w.

804. Fall of a Building With Cast Iron Columns (Building at corner of W. Broadway and Third St., New York). Eng News–Aug. 15. 1100 w.

824. Projected Tests of Fire-proofing (Outlines the work to be done by a committee appointed by fire insurance companies, architects and engineers in an investigation of materials and methods of fire-proofing). Eng Rec–Aug. 17. 450 w.

*830. Art in Churches (Abstract of remarks by the Archbishop of York at the dedication service in Lichfield Cathedral, when some stained-glass windows were unveiled). Arch Lond -Aug. 9. 1800 w.

*831. Egyptian Discoveries. L. E. Steele, in the Irish Times (An account of the results of last winter's explorations). Arch Lond–Aug. 9. 3300 w.

835. The Style for a New Cathedral. From the Building News (Criticism of Mr. Flagg's article on the subject). Am Arch–Aug. 17. 1900 w.

840. The Lexington Building. Ill. G. B. Waite (Description of the building in which the motive power and machinery of the Lexington Ave. cable railroad is to be located). Arch & Build–Aug. 17. 1800 w.

841. The Influence of Literature on Architecture. Arthur T. Bolton (Literature, defined as thought, influences religious architecture. Reprinted from the Jour. of the Roy. Inst. of Brit. Arch). Arch & Build–Aug. 17. Serial. 1st part. 3500 w.

*844. Rudiments of a Wall. Alexander Black (A wall defined ; materials used, principles, &c). Ill Car & Build–Aug. 9. 1700 w.

*845. Old-Time Houses (American and English. Describes characteristic and typical houses of a bygone generation in both England and the United States). Ill Car & Build–Aug. 9. 1500 w.

†878. Richard Morris Hunt. P. B. Wight, with Editorial (Biographical sketch, with partial list of his important works). In Arch–Aug. 6400 w.

922. Some Details of the Ireland Building. Ill. (Evidences of the cause of the disaster). Eng News–Aug. 22. 2300 w.

969.—75 cts. The Advisability of the Registration of Architects. C. Howard Walker (Favoring legal registration and the institution of penalties for illegal use of the name; also discussing qualifications necessary). Arch Rev Vol. III., No. 7. 2800 w.

*974. Old English Homes (Descriptive). Ill Car & Build–Aug. 16. 3500 w.

*975. House Building Hints (Requisites for a pleasant, healthy home). Ill Car & Build–Aug. 16. 1000 w.

976. Steel Beam Footings—How Should They Be Used and Calculated ? (Calling attention to the probable action of beams when loaded, and to some conclusions in regard to the disposition of the beams and their calculation) Ill. F. E. Kidder. Arch & Build–Aug. 24. 2800 w.

*990. Architects' Responsibility for Extra Charges (Experience of a Liverpool Architect. Toxteth Infirmary lightning conductor). Brit Arch–Aug. 16. 2200 w.

*1009. Cracks in Brickwork and Plastering. A. H. Dyer. Ill. (What causes them and how they may be prevented). Br Build–Aug. 2000 w.

1036. Corrected Details of the Ireland Building. Eng News–Aug. 29. 1400 w.

1077. The Ireland Building Wreck, New York. Ill. (Details of points of failure). Eng Rec–Aug. 31. 4000 w.

*1145. The Japanese National Industrial Exhibition in Kioto. Ill. (Description of buildings and grounds). Am Eng & R R Jour–Sept. 2800 w.

1162. Tallest Chimneys on Earth. W. Barnet Le Van (A number of high structures with a list of chimneys over 150-ft. with the names of their builders). Mach–Sept. 900 w.

*1180. The Careless Construction and Willful Destruction of Buildings. Ill. Louis Windmüller (Accounts of some faulty constructions, calling attention to dangerous practices, and evils arising from insurance). Rev of Rev–Sept. 1900 w.

1192. Historic Architecture in Normandie. Ill. Howard Crosby Butler (Historical and descriptive). Arch & Build–Aug. 31. Serial. 1st part. 3500 w.

1195. The Sanchi Tope. Ill. J. B. Braddon (Description of the famous Sanchi Tope, in Bhopal, British India). Am Arch–Aug. 31. 700 w.

1203. Manufacture of Marbleized Slate Mantels. Ill. (Description of the process at a Jersey City plant). Sci Am–Sept. 7. 800 w.

1280. The Verdict of the Coroner's Jury in the Case of the Ireland Building (A case of great importance to architects and builders). Arch & Build–Sept. 7. 1700 w.

*1281. Architecture for the Amateur (Editorial review of book by H. Heathcote Statham). Brit Arch–Aug. 30. 1600 w.

*1282. The Design of a Column. Ill. H. Heathcote Statham (From "Architecture for General Readers, by Author). Brit Arch–Aug. 30. 700 w.

*1283. Some Defects in Modern Architectural Training. T. G. Jackson (Excerpts from address delivered at the opening of the Liverpool School of Architecture and the Applied Arts). Brit Arch–Aug. 30. 1400 w.

1284. A Series of Fireproofing Tests (Tests made under the direction of F. E. Cabot, in the presence of John S. Damrell and M. W. Fitzsimmons. Tests instituted by Willard T. Sears for the purpose of obtaining accurate data regarding the value of several different systems of fire-resisting construction). Am Arch–Sept. 7. 3000 w.

1285. Spanning Spaces. From the Building News (The problem that has been the motive of every great architectural style of the past. Review of methods and progress). Am Arch–Sept. 7. 2300 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Inland Navigation—Germany.

In *The London Engineer* (Aug. 2) an article under the above title gives many valuable facts relating to the experience in Germany with river and canal navigation. The same journal published (Oct. 7–21, 1892) a similar article on the French inland waterways. At a time when our railroads dare cut rates no farther, when the merchant is trying to reduce all his transportation expenses to a minimum, and when several canal projects are under way, such information is particularly welcome. The article is accompanied by a map of Germany. These waterways extend from east to west through the empire, with numerous branches leading them to the ocean, thus connecting the central part of the empire and the principal shipping ports with a cheap and efficient system of transportation. After describing these routes in detail, the article continues: "Since 1880 the Prussian government has regarded the improvement of waterways for the carriage of bulky goods as of national importance, and has both regulated many of the rivers and extended the canal system. A programme was adopted at that time, and the estimated cost of completing this amounted to £4,500,000 ($22,500,000), to be spread over a period of 18 years. . . . The above amount has been supplemented by further votes to the extent of £6,200,000 ($31,000,000), making a total of £10,700,000 ($53,500,000). The expenditure in 13 years amounted to £2,354,550 ($11,772,750). The cost of maintaining German waterways in 1893 amounted to £500,000 ($2,500,000), equal to about £70 ($350) per mile. This is divisible into £60 ($300) per annum as the average expenditure on canals, while the river navigations cost £84 ($420) per mile to keep in order. . . . From a memorandum laid before the Prussian parliament in 1890, we find a statement of work done during the previous 10 years, and the result. The chief features are the greater size and carrying capacity of vessels. Canals have nearly all been opened to steamers, and steam navigation has increased considerably. In 1880 the largest vessels navigating the Rhine did not carry above 900 tons. Now they reach 1300 tons. The number of vessels has increased 25 per cent.,—6250 being employed as against 5000 10 years previously. Steamers ply between Cologne and London; also to Bremen and various Baltic ports. They are 200 ft. long, 28 ft. 6 in. beam, and have a displacement of 300 tons on a draught of 8 ft. On the Wesser the capacity of barges has been doubled from 150 tons to 300 tons and upward. On the Elbe boats are now carrying 800 tons as against 500 tons in the former period. Following the improvements, the developments of traffic have been considerable, especially on the Rhine and Elbe. The data are not sufficiently complete to admit of a trustworthy statement being framed, giving the amount of goods carried by water. If all the tonnage returns are added together, the total increase for the year 1892 above the average total for the years 1881 to 1885 would appear to be 50 per cent. This is an approximation, which, however, is borne out to a certain extent by the returns showing the number and tonnage of vessels employed at the two periods."

Here follows an itemized table, showing the character and number of vessels in 1882, 1887, and 1892, indicating that "the number of vessels under 100 tons has diminished by about 10 per cent. The number of iron sailing vessels increased from 839 in 1882 to 2707 in 1892," and there was an increase in tonnage of 66 per cent. The number of freight cars on the railroads, however, increased 30 per cent., though their capacity remained about the same. Concerning the organization the journal says: "Most of the rivers yield no direct returns, as navigation is free. The tolls levied on canals are extremely low, and there is no expectation of making them self-supporting. The tolls are collected by the minister of finance, the expenditure comes under the public works vote, and no balancing of accounts is attempted. Approximately, the receipts from lock dues on rivers and canals amount to £67,000 ($335,000) per annum, and compares with £48,000 ($240,000) received in France. In some cases tolls have been raised of late years, but many locks are free. For instance, there are sixteen locks between Berlin and Stettin, but on only two of them are tolls levied. The general result to be gathered from the past and present. condition of inland navigation in Germany appears to be that, where there is really large traffic, waterways can be constructed to pay and to compete with railways on their merits, but the traffic must be forthcoming in considerable quantity in order to pay for working expenses, maintenance and interest on money; and that, given sufficient cargo capacity, vessels can be worked from place to place much more cheaply than railway trains. The public works minister of France has stated the minimum cost of carriage at which goods traffic can be conveyed on railways so as to pay its way is 0.592 d. per ton per mile. The Belgian minister considers that in his country it should be 0.483 d. per ton per mile, whereas the Prussian minister gives the lowest remunerative charge as 0.40 d per ton per mile. Sir G. Findlay told committees that the actual cost of conveying train-loads of coal from Wigan to London and returning empty wagons amounted to 0.21 d. per ton per mile in 1870, and 0.24 d. per ton per mile in 1874. As compared with the above rates, we find that the freight for 'bulk goods' from Hamburg to Magdeburg, a distance of 187 miles, varies between .064 d. and .16 d. per ton per mile; 'various merchandise' being charged 0.32 d. to 0.51 d. per ton per mile. To Berlin, a distance of 240 miles, coal is carried at freight rates varying from 0.10 d. to 0.175 d. per ton per mile. Pig iron pays a little lower, while grain pays a somewhat higher rate. To Aussig, 417 miles, 'bulk goods' are charged from 0.144 d. to 0.18. d per ton per mile; merchandise, 0.23 d. to 0.287 d. per ton per mile. These conveyance rates would all allow of an additional toll being levied, so as to make the waterways self-supporting, and yet show a considerable reduction in the lowest remunerative cost of carriage by rail. Freights vary according to the nature of the cargo, state of the markets, and condition of the rivers. Steamers command a somewhat higher rate. Vessels navigating the waterways are variously owned by private individuals,—owners of one or more barges and steamers,—by firms owning numbers of craft, and also by important navigation companies, some with a capital of over £1,000,000 sterling. There is also an association for insuring vessels and cargoes under different classes, showing that the traffic is systematically provided for." The article then continues with a description of the funds against sickness, accident, and old age; and the statement that "canals are considered useful in Germany in relieving railways of a large amount of heavy goods traffic, and by acting as a check on railway rates."

The Ireland Building Disaster.

IN these days of tall buildings occupied by our brightest business men and filled with offices for the transaction of their affairs, the collapse of this large New York office building is significant. The fact that we live in an age of bustle is no excuse for mistakes and inefficiency in places of responsibility. Speaking of this disaster, the *Engineering News* (Aug. 22) says: "From the testimony already before the coroner's jury, and from the silent testimony given by the fractured columns and by the parts of the structure which still remain in place, it appears that the owner employed a cheap architect, who was paid only one per cent. commission on the cost of the building for his plans and superintendence; that the contractor for the structure was induced to lower his original bid about ten per cent., or $6700, to obtain the work that this contractor substituted a foundation stone of micaceous schist, or similar weak stone, for the granite called for by the specifications, and that he laid under it 12 in. of concrete, instead of 18 in., as he agreed to do; that the contractor for the ironwork furnished columns which were of light weight, of hard and brittle iron, much thinner on one side than on the other, and full of blowholes; that the roof was enormously heavy, and, in addition, was weighted with bags of gravel; that the plasterer piled bags of plaster one above the other on the floors of the unfinished structure; that the design of the roof beam supports was defective, in that the beams rested on supporting plates of insufficient thickness and were not bolted or otherwise fastened to the columns; that the architect did not efficiently superintend the construction, did not know the existence of an old cistern in the vicinity of the foundation of the column, was not aware of the deficient thickness of the concrete bed until after the accident, and made no objection to the other defects in material or to deficient roof support; and that the city building inspector reported no faults in any of the materials or workmanship."

The roof of same construction as the floor was supported by single I-beams, four ends resting on the top of each hollow 8-in. cast-iron column with no other cap than a ½-in. bead. "On top of this, without fastening of any kind, rested a thin flat cast-iron plate about 6 in. wide by 0.75 in. thick with a flange 0.75 in. high on each side. This plate projected about 2-in. beyond the bead on each side of the column. On each end of this plate the end of one of the I-beams of the principal girder rested without fastening of any kind and in such a manner that its weight may have been brought entirely on the overhanging part of the plate. . . . It is easily seen that, if there was a slight warping of the plate or of the beam, or of both, the weight of the beam may have been brought on the extreme end of the overhanging plate instead of on a point immediately above the bead, and in that case the plate would be liable to fracture by transverse strain."

The beams resting on the ends of this cast-iron plate bore the heaviest load, rendering it sure that the slightest defect in the ¾-in. cast-iron plate would be located by a heavily-loaded beam. One of the columns in position on the eighth, or top, floor shows that this actually happened, and the released beam dropped, displacing those on the column at its other end, the whole breaking through the seventh and each consecutive floor, until it lay a dusty heap of *débris*, covering the crushed workmen beneath it. And yet such disasters are to be expected when a man employs an architect for half of what he should receive, and lets his contract to a man at a price that will ruin the contractor, for cheap work is usually poor work.

Later excavations have shown the immediate cause of the collapse to lie in the foundation of the center column. "This column [*Engineering News*, Aug. 29] originally rested on a cast-iron plate 3 in. thick, this on a stone which, instead of being granite as the specification required, was a weak, soft, micaceous schist, pieces of which could be broken off with the fingers. This stone was about 4 ft. square and 12 in. thick. It rested on a block of concrete 12 in. thick, which, according to the building laws, should have been 18 in. thick." In excavating for the concrete block the workmen came upon an old cistern reaching not quite to the center of the foundation. The soil adjacent was "practically a quicksand, composed of exceedingly fine grains of sand with considerable mica and with very little clay or loam in it." The concrete foundation, therefore, rested, one corner on a comparatively rigid foundation composed of the walls and concrete filling of the cistern, and the remainder on a wet quicksand. Mr. Chas. O. Brown, in the same issue, gives an opinion as follows: "When the concrete cracked, a certain drop must have taken place of from 3 to 4 in., giving the column an impetus, tilting the fragments of the stone and concrete, and making further progress easier. When the flanges around the base of the column cracked, another drop of 3 or 4 in. must have taken place, leaving the bare shaft of the column 15 in. in diameter with a load of 140 tons per square foot to pierce a soil which cannot be relied on to support 1½ tons per sq. ft. The center column naturally brought down the ends of the girders resting on the same with it," and caused the breaking of the supports of the ends of the beams as described.

The Panama Canal.

It appears that no definite plan has yet been determined upon for the proposed completion of the Panama canal, and that the main difficulties are quite as perplexing as ever before. The chief engineer of the new company has lately presented a report to the directors, which has not yet been published in full; but the London *Railway Times* quotes from a newspaper correspondent an extract from the report, which is of considerable interest. It refers to the heavy cutting at Culebra, which, in all the projects, is established for a single line of vessels; but, even with a 45° slope, the canal at the bottom would be only 21 meters wide. This the chief engineer considers altogether insufficient for large vessels (say, up to 18 meters beam), and he asks how such vessels could be moved in so narrow a space at speed enough to allow steerage way. In front of the vessel there would be a very high wave which would impede its progress. Frequent accidents would have to be feared, and also the stranding of vessels, which would stop navigation. Lastly, the banks of the canal would be seriously threatened, and landslips might occur. The technical commission, says the engineer, considered that for the commencement of the working of the canal a width sufficient for one line of vessels might be accepted; but it would be indispensable to widen it very shortly for a double line of vessels, and this improvement, the commission thought, could always be effected when necessary, as had been done for the Suez canal, and that the dilapidation of the banks could be prevented by a double facing. But M. de la Tournerie (the chief engineer) does not believe that the widening could be done without stopping navigation. In another part of the report he refers to the difficulties of controlling the torrential Chagres river, and it seems that it is still unsettled how large the relief lakes for catching the floods should be.

A Large Bucket Dredge.

The Engineering News, (September 19) contains the following description of a new dredge fitted with a pulverizer used in work at the port of Libau, Russia. "The tenacious clay and marl dredged up are reduced to liquid mud by revolving steel arms and water jet, so that it can be pumped ashore through pipes by a centrifugal pump. . . . The dredge is 180 feet long, 35 feet beam, and 14 feet deep, and is fitted up with twin-screws driven by compound condensing engines of 800 I. H. P., giving a speed of seven knots per hour. One of these engines also works the dredging plant, and pulverizer, while the other works the centrifugal pump and the hauling winches. Steam is supplied by two steel boilers at 100 pounds pressure, either boiler alone being able to work the dredging machinery to its full power. The vessel is lighted by electricity. The buckets can lift about 600 tons of material per hour, and the machine has records of 6000 tons in a working day, and 62,700 tons a month raised and deposited."

The Great Sheridan Road.

Paving and Municipal Engineering (Sept.) speaks as follows regarding one of Chicago's new enterprises. "The greatest project in roadbuilding undertaken in recent years in America is the Sheridan road, fittingly referred to often as 'the great Sheridan road.' A few public-spirited citizens of Chicago have, with admirable courage and by indefatigable efforts, brought it through the difficult stages of advancement from a supposedly unrealizable, but grand, conception to the point of assured accomplishment. How this has been done is in itself a story of the almost infinite possibilities of human intelligence and perseverance. In the beginning it was proposed that it should be a boulevard between Chicago and Fort Sheridan,—the advocates hardly dared to propose more,—but, now that the way has been blazed, after years of untiring work, through seemingly insurmountable difficulties, it is to be, in the words of a Chicago writer, '250 miles of smooth road, at times skirt-ing the breakers of old Lake Michigan, now plunging into the forest, and again meandering through the finest farming country the sun ever smiled upon. Such is to be the future of the Sheridan road. Picture a broad highway extending from Chicago to Milwaukee; from Milwaukee through the lake dotted and river-entwined country which separates the Cream City from Lake Geneva; imagine that highway winding around the verdure-covered hills which overlook that superb body of water from the village of Geneva lake to Williams bay; continue that road across the State line until it strikes the Fox river, through Huntley, Algonquin, classic old Dundee, and beautiful Elgin, and from the city of watches follow the route familiar to all lovers of bicycling past St. Charles, Geneva, Batavia, Aurora, Downer's Grove, and Hinsdale, until it connects with the West Park boulevard system, and you will have a faint prophetic vision of the Sheridan road of the next decade. All this has been made possible by the passage of the Sheridan road bill by the Illinois general assembly and its probable enactment by the Wisconsin legislature. It provides for the creation of park districts and the control of submerged lands and those bordering on navigable bodies of water. Through the creation of these park districts and the acquirement of land by condemnation for the purpose, a way is opened for the road, and its construction and maintenance provided for. The bill is a long one, and is a good model for similar projects in other States." The movement originated in 1887 at the home of a Chicago citizen, and is headed by Mr. Volney W. Foster as president of the Sheridan Road Association. Though the original purpose was to construct a pleasure drive from Chicago to Fort Sheridan, there was so much encouragement shown to the enterprise that it has grown to the magnitude indicated. Active construction is in progress on "almost every section between Chicago and the Wisconsin State line." Governor Altgeld is reported as saying that "the Sheridan road is one of the great achievements of the century. There will not be such another road in the world, and it will bring a harvest of honor to the men who are giving it time and effort."

Standard Specifications for Structural Steel.

In the struggle for standards by universal agreement, the following specifications, setting forth what the manufacturers have agreed upon, are a big step. The Steel Manufacturers' Association, which adopted it, is composed, according to *The Iron Age* (Sept. 5), of "the Illinois Steel Co., Carnegie Steel Co., Jones & Laughlins, Carbon Steel Co., Cambria Iron Co., Penna. Steel Co., Pottstown Iron Co., Shoenberger Steel Co., Spang, Chalfant & Co., Otis Steel Co., Ltd., Cleveland Rolling Mill Co., and others.

"SPECIFICATION.

"*Process of Manufacture.*—1. Steel may be made by either the open hearth or bessemer process.

"*Test Pieces.*—2. All tests and inspection shall be made at place of manufacture, prior to shipment.

"3. The tensile strength, limit of elasticity, and ductility shall be determined from a standard test piece cut from the finished material and planed, milled, and turned parallel. The elongation shall be measured on an original length of 8 in., except when the thickness of the finished material is $\frac{5}{16}$ in. or less, in which case the elongation shall be measured in a length equal to sixteen times the thickness; and except in rounds of $\frac{5}{8}$ in. or less in diameter, in which case the elongation shall be measured in a length eight times the diameter of section tested. Two test pieces shall be taken from each melt or blow of finished material,—one for tension and one for bending.

"3 *a*. Material which is to be used without annealing or further treatment is to be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimen representing such material is to be similarly treated before testing.

"4. Every finished piece shall be stamped with the blow or melt number; and steel for pins shall have the blow or melt number stamped on the ends. Rivet and lacing steel and small pieces for pin plates and stiffeners may be shipped in bundles securely wired together, with the blow or melt number on a metal tag attached.

"*Finish.*—5. Finished bars must be free from injurious seams, flaws, or cracks, and have a workmanlike finish.

"*Grade of Steel.*—6. Steel shall be of three grades,—rivet, soft, and medium.

"*Rivet Steel.*—7. Ultimate strength, 48,000 to 58,000 lbs. per square inch. Elastic limit, not less than half the ultimate strength. Elongation, 26 per cent. Bending test, 180 degrees, flat on itself, without fracture on outside of bent portion.

"*Soft Steel.*—8. Ultimate strength, 52,000 to 62,000 lbs. per square inch. Elastic limit, not less than one half the ultimate. Elongation, 25 per cent. Bending test, 180 degrees, flat on itself, without fracture on outside of bent portion.

"*Medium Steel.*—9. Ultimate strength, 60,000 to 70,000 lbs. per square inch. Elastic limit, not less than one half the ultimate. Elongation, 22 per cent. Bending test, 180 degrees, to a diameter equal to the thickness of piece tested, without fracture on outside of bent portion.

"*Pin Steel.*—10. Pins made from either of the above-mentioned grades of steel shall, on specimen test pieces cut at a depth of 1 in. from surface of finished material, fill the physical requirements of the grade of steel from which they are rolled for ultimate strength, elastic limit, and bending; but the required elongation shall be decreased 5 per cent.

"11. Eye bar material, 1½ in. and less in thickness, made of either of the above-mentioned grades of steel, shall, on test pieces cut from finished material, fill the physical requirements of the grade of steel from which they are rolled. For thickness greater than 1½ in. there will be allowed a reduction in the percentage of elongation of 1 per cent. for each ⅛ in. increase of thickness to a minimum of 20 per cent. for medium steel and 22 per cent. for soft steel.

"*Full-Size Test of Steel Eye Bars.*—12. Full-size test of steel eye bars shall be required to show not less than 10 per cent. elongation in the body of the bar, and tensile strength not more than 5000 lbs. below the minimum tensile strength required in specimen tests of the grade of steel from which they were rolled. The bars will be required to break in the body, but, should a bar break in the head, but develop 10 per cent. elongation and the ultimate strength specified, it shall not be cause for rejection, provided not more than one-third of the total number of bars tested break in the head; otherwise the entire lot will be rejected.

"*Variations in weight.*—13. The variation in cross-section or weight of more than 2½ per cent. from that specified will be sufficient cause for rejection, except in the case of sheared plates ordered to gage; in which event there will be permitted an excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table:

TABLE OF ALLOWANCES FOR OVERWEIGHT FOR RECTANGULAR PLATES.

Width.	Per cent. allowance for given thickness of plate in inches.							
Thickness in inches..........	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	over $\frac{5}{8}$
Up to 75..........	10	8	7	6	5	4½	4	3½
75 to 100..........	14	12	10	8	7	6½	6	5

"*Specifications for Structural Cast Iron.*—1. Except where chilled iron is specified, all castings shall be tough gray iron, free from injurious cold shuts or blow holes, true to pattern, and of workmanlike finish. Sample pieces, 1 in. square, cast from the same heat of metal in sand molds, shall be capable of sustaining on a clear span of 4 ft. 8 in. a central load of 500 lbs. when tested in the rough bar."

In the grading of the steel an "extra soft steel" was included, having an ultimate strength of 45,000 to 55,000 lbs. per square inch, and an elongation of 28 per cent. This steel is used for such purposes as boiler rivets. The above is interesting as showing the manufacturers' idea of a specification. As will be seen, there is a great deal of latitude allowed, no mention being made of composition or of guaranteeing the tests; nevertheless, it represents pretty closely actual practice at the works, where specifications are not furnished by the purchaser.

The Effect of Artificial Diversion upon the Commerce of the Lakes.

SINCE the inception of the various plans to utilize water from the great lakes through diversion into other channels than those occupied during historic times, much speculation has resulted as to the effect of such diversion upon lake traffic and upon the falls of Niagara. *The Iron Age* of July 4, in an editorial entitled "The Chicago Canal and Lake Commerce," says, basing the remarks upon data prepared by C. H. Keep, secretary of the Lake Carriers' Association: "A lowering of the lake levels by 3 in. would produce a diminution of the carrying capacity of the lake fleet in a season amounting to 1,142,370 tons; a lowering of the lake levels by 6 in. would diminish the carrying capacity 3,427,110 tons." It estimates that the money loss due to a lowering of 3 in. would amount to $571,185, and that due to a lowering of 6 in. to $1,142,370. It is estimated by Thomas T. Johnson, of the Chicago drainage canal, that the latter, when taking its maximum capacity, will lower the level of Lake Michigan between 5 and 6 in. The editor thinks that, in view of the wide fluctuations in the levels of the great lakes due entirely to natural causes, the accuracy of calculations of this kind may be questioned.

Pipe Line for Clay.

THE staple industry of the neighborhood of Sittingbourne, England, is brickmaking, and a firm there, says *Brick*, for August, has just bought 45 acres of brick earth at Highsted. The clay will be washed on the spot and will be conveyed by means of pipes to the works belonging to the firm at Murston, a distance of 2 miles.

This enterprising firm has for some years taken their supply of clay from Tong, at about an equal distance, whence, after washing, it was piped to their works, so the system is by no means an experiment.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Bridges.

*721. New Stiffened Suspension Bridge over the Danube. Ill. (Competition designs). Eng, Lond–Aug. 2. 1000 w.

729. Hydraulic Field-Riveting in France. Review of article by M. Geoffroy. Eng Rec–Aug. 10. 750 w.

*858. The New Waverley Bridge, Edinburgh. Ill. (Details of structure. Descriptive). Eng, Lond–Aug. 9. 2500 w.

*1028. Wooden Bridge Construction on the Boston and Maine Railroad. Ill. J. Parker Snow (Read before the Boston Society of Civil Engineers. Description of present practice with detail drawings). Jour Asso Eng Soc–July. 5500 w.

*1081. Rutherglen Bridge (Illustrated with views and drawings. Will bridge the Clyde with three spans). Eng, Lond–Aug. 23. 2500 w.

1208. The Reactions of Partially Continuous Drawbridges. Mansfield Merriman (A paper read before the Section of Mechanical Science of the Am. Asso. for the Advancement of Science. A thoroughly general scientific discussion with development of formulæ). Eng News–Sept. 5. 1500 w.

1209. Determining the Deflection of Swing Spans (Short, concisely stated method for calculating strains and deflection of drawbridge spans). Eng News–Sept. 5. Table.

1270. A Standard Combination Highway Bridge. Ill. (A combination Pratt truss with steel tension and wood compression members, outline specification, and details of fastenings, etc. Especially adapted for western territory). Eng Rec–Sept. 7. 850 w.

Canals, Rivers and Harbors.

*720. Inland Navigation—Germany. Map (Describing rivers and canals; statistics of traffic). Eng, Lond–Aug. 2. 3500 w.

765. The New Canal at Sault Ste. Marie. Ill. (Descriptive application of electrical machinery for operating the lock gates and valves of canal lock). Can Elec News–Aug. 4000 w.

802. Sounding Boat Used on the Danube River Improvement. Ill. (A system of sounding that determines the contour of the river bed with an accuracy which has probably never been equaled). Eng News–Aug. 15. 700 w.

*861. Opening of the Southampton Graving Dock (Picturesque ceremony). Trans–Aug. 9. 4000 w.

918. The Proposed New York-Philadelphia Ship Canal (Report upon the progress made and including the official reports of N. H. Hutton

and L. M. Haupt). Eng News–Aug. 22. 1100 w.

1034. The Swan Lake Reservoir and Canal System, Utah. Ill. W. P. Hardesty (Description with map and illustrations of new form of headgate). Eng News–Aug. 29. 3000 w.

1038. The Proposed Atlantic Coastwise and Cape Cod Canals. Ill. (A short route from Boston to Philadelphia involving a canal across Cape Cod peninsula and across New Jersey. Map and sections). Sci Am–Aug. 31. 800 w.

*1137. The Ship Canal and Its Prospects (Financial condition and prospects of the Manchester Ship Canal). Trans–Aug. 23. 1200 w.

*1190. The Manchester Canal (Statement of financial condition). Ir & St Tr Jour–Aug. 24. 500 w.

1204. Dredging and Floating Pipe System. Ill. (Description of pipe, with flexible joints, used on the North Sea Canal). Sci Am–Sept. 7. 600 w.

1211. Concerning the North Sea and Baltic and the Suez Ship Canals. E. L. Corthell (Brief description with revision of details up to date). Eng News–Sept. 5. 1100 w.

*1237. Description of the Harbor of Batavia. Ill. M. G. de Gelder (A full description of the plan and work in dredging and removing coral banks with cost and capacity of machines used. Work was done by the Dutch government at a cost of £1,548,000). Eng, Lond–Aug. 30. 2200 w.

*1278. Harbor Construction in Spain (A scheme to improve the harbor of Bilbao, consisting of a breakwater 1600 yards long, and a countermole which will form an outer harbor). Trans–Aug. 30. 2000 w.

Hydraulics.

910. Pumping Water by Compressed Air. Ill. (An account of the Pohlé system, which has been introduced into Canada by the Ingersoll-Sargeant Drill Company, of Montreal). From the Can Eng. Sci Am Sup–Aug. 24. 1000 w.

911. Pumps and Pumping Machinery. William Perry (Historical). Sci Am Sup–Aug. 24. 3000 w.

919. Hydraulic Shield for the Blackwall Tunnel under the Thames. Ill. (Descriptive). Eng News–Aug. 22. 1400 w.

†1141. The Pelton Water Wheel. Ill. (The report of the Franklin Institute, through its Committee on Science and the Arts, on the invention of Lester A. Pelton, with appendix of historical notes and data by the sub committee). Jour Fr Inst–Sept. 10500 w.

1272. The Economic Velocity of Transmission of Water Through Pipes. George W. Tuttle (The results of original investigations on the most economic relation between diameter and velocity of water in pipes with derivation of formulæ in which cost enters as an item. A valuable contribution). Eng Rec–Sept. 7. 1500 w.

Miscellany.

*694. The Newhouse Tunnel at Idaho Springs. Ill. Arthur Lakes (A notable mining enterprise). Eng Mag–Oct. 3700 w.

771.—75 cts. A Discussion of State Legislation on Highways in the United States. Roy Stone. Tech Quar–April. 5800 w.

823. Subaqueous Tunnel Work.—The Hudson River Accident. J. F. Anderson (Gives particulars relating to this accident and of circumstances which led up to it, not before published). Eng Rec–Aug. 17. 3000 w.

*846. The Abuse of Cement. D. B. Butler. (Treatment often the cause of failure ; inattention to setting properties ; dirty aggregate ; proper maturing before use ; protection from extremes of temperature). Ill Car & Build–Aug. 9. 900 w.

888. A Costly Feature of Canal Navigation. (Loss of time, caused by breaks, and losses in consequence). Ry Age–Aug. 16. 2000 w.

920. Formulas for Long Columns. A. J. Du Bois (A new rational formula that includes all the others as special cases). Eng News–Aug. 22. 2800 w.

*931. The Severn Tunnel. Leveson Francis Vernon-Harcourt (From brief notices of works published by the Inst. of Civ. Eng.) Col Guard–Aug. 16. 1200 w.

*1026. Timber-Preserving Methods and Appliances. Ill. W. G. Curtiss (A description of a portable wood-preserving plant recently put into successful use on the Pacific System lines of the Southern Pacific Company). Jour Asso Eng Soc–July. 8000 w.

*1029. The Engineering History of a Law Suit Respecting a Contract for Railroad Building in South Dakota. Francis C. Tucker (Read before the Boston Society of Civil Engineers. An interesting paper. Decision of the Court). Jour Asso Eng. Soc–July. 4800 w.

1039. The Boston Subway. Ill. (Description of the four track underground trolley line now being built in Boston). Sci Am–Aug. 31. 1100 w.

*1104. The Great Sheridan Road. Ill. (The greatest project in road building undertaken in recent years in America. A pleasure drive of 250 miles out of Chicago). Pav & Mun Eng–Sept. 1600 w.

*1105. Important Facts Regarding Cement and Its Use (An epitome of the practice in the use of cement). Pav & Mun Eng–Sept. 1000 w.

1156. Standard Specifications for Structural Steel (Adopted by the Steel Manufacturers' Association, which includes the principal manufacturers of the United States). Ir Age–Sept. 5. 1200 w.

1271. Details of Construction of Engineering Structures. C. C. Schneider (Reprinted from Trans. of the Asso. of Civ. Eng. of Cornell Univ.) Eng Rec–Sept. 7. Serial. 1st part. 2000 w.

1294. Improvement of Highways by Convict Labor. Roy Stone (Advocating the system showing that it would be economical, and showing how it may be done. Also advocating steel rails for wagon use to reduce traction). Ry Rev–Sept. 7. 1700 w.

DOMESTIC ENGINEERING

Sanitary Plumbing.

A LECTURE delivered by Cesare J. Marani before the Engineering Society of the School of Practical Science, Toronto, and printed in *Domestic Engineering*, is instructive. The attitude of the common run of architects toward this class of work is discussed in the first part of the lecture, and it is asserted that the average architect possesses little or no scientific knowledge whatever on the important subject of sanitary engineering, thus clearly demonstrating that "he and the rest of the profession attach too little importance to their responsibilities in connection with the plumbing of buildings, and therefore do not seem to experience for this that feeling of personal accountability, so essential to success, which they do for other and less important sections of their work."

Mr. Marani does not refer to the average member of architects' associations, but the average of all who are practising architecture, a great many of whom have not the qualifications and attainments that would enable them to gain a membership in a respectable architectural club; and in this connection he quotes Colonel E. Waring as saying:

"I have never applied a water test, under pressure, to work that has been done in a fine house under control of an architect with any other result, so far as his frame of mind was concerned, than to annoy him by the demonstration of leaks and defects.

"What seems still more remarkable, when I have sometimes thought that I had an architect really converted, when he acknowledged the work to be simple, elegant, safe, cheap, and in every way satisfactory, is that the conversion never lasted. I never found that the example had the slightest influence on him afterwards."

While outlays that will *manifestly* add to the comfort or luxury of a house are not seriously objected to, such as will secure its sanitation without show, or promise of immediate personal ease or comfort, are objected to. Not only this "ostrich-like policy, but the pandering to it on the part of architects, is to be regretted."

A case is cited wherein an architect justified himself for paying no attention to plumbing details on the ground that "he had employed the best plumber in the town" to do the work, and that therefore the work would be certainly done well. "But," asks the lecturer, "who constitute the best practical plumbers" in a community? "Are they men of science as well as clever mechanics? Are they fully entitled by a sound experience and careful study of their trade to the full import of such an appellation? I fear not, and certainly much less to that signification which a too confiding public is ever sure to place on such titles. It is a fallacy to imagine that the knowledge of how to handle, cut, and connect pipes, and wipe joints, of necessity makes a man master of the plumbers' trade. And yet I have known from experience that in the great majority of cases this is regarded as the criterion. It might seem that the impression prevails among a large class of pipefitters and mechanics that the possession of a certain number of working tools, together with the valuable assistance of a couple of incompetent 'shop boys,' a large shingle suspended over the sidewalk, more pronounced in its economy for truth than expense, a few cast-iron connections displayed just outside the shop, and lots of gas-brackets and other brass fixtures inside, constitutes a man at once a practical plumber. There are a great many good workmen who are by no means practical plumbers and sanitary engineers, as they often style themselves."

The architect is therefore inexcusable for leaving plumbing work wholly to the assumed knowledge, skill, and fidelity of the "best plumber in the town." He himself ought to have the theoretical knowledge to be able to see that no principle of good plumbing is violated; then, if he pleases, he may rest in the belief that the best plumber in town will be able to make a tight job, which will stand a test under his supervision. What "the best plumber in town" can sometimes do is illustrated by the following instance:

"Not very long ago a case came under my notice in this city, where a long vertical line of soil pipes had choked and blocked up completely. It was thought, at first, that the servants must have thrown rags, etc., down the closets, but further examination showed that there was nothing in the pipes, save the legitimate house waste and closet paper.

"The plumbers, in erecting the said line of pipes, had used too little gaskets in some of the joints, and none at all in others. The consequence was that the lead intended for the joints had spurted inside, in some cases forming regular groups of fingers across the pipes, thus obstructing the passage of paper, etc. The only way this could be rectified was by the tearing down and reconstructing of that vertical line of soil pipes."

The "unit of sanitary adminstration" is the house. "In fact, the whole system beyond, with its many intricacies and problems, both mechanical and financial, never would have been developed, nor ever have sprung into existence, but for the dwelling."

Effects upon Health of the Products of Gas Combustion.

PROFESSOR H. CHR. GEELMUYDEN has contributed to *Archiv für Hygeine*, 1895, Vol. XXII, No. 2, an account of an investigation carried out by him as to the effects upon health of the products of gas combustion, and as to the presence of these products where gas is used as an illuminant, etc. This account having been copied in *Journal für Gasbeleuchtung*, *The Gas World* (July 6) prints an abstract of it. The experiments were performed in the laboratory of the Physiological Institute of the University of Christiania, and occupied 6 months. The necessity for the experiments is explained by the fact that recorded results of older experiments cannot be assumed to apply to products of combustion of gas produced by newer and improved methods, and that in different locations and with different qualities of coal the composition of illuminating gas varies, even when manufactured substantially by the same process. "Much of the older work had therefore to be gone over again; and the result showed that it was well to have done so. Gas, if it escapes from the pipes, is, of course, a powerful poison; but the question here was as to its products of combustion; and in this investigation it is limited to the products of the combustion of gas when it is used as a lighting agent, not when used for heating or for cooking in confined rooms. In these cases the products of combustion, whatever they may be, should always be taken off by a chimney, and therefore do not come into the question at all. In most cases of lighting, on the other hand, the products of combustion escape into the room; and that is the case now inquired into."

The question to be solved in these experiments was not whether gas burned in "old-fashioned or worn-out burners is prejudicial to health," but whether the average gas, burned in really good burners, is so. "The answer is favorable to gas." The gas used was Christiania gas; the results might be different, particularly as regards the sulphur compounds, if the gas of some other town were tested. Christiania gas is, according to the gas-works chemist, Herr Mejländer: hydrogen, 47 per cent., by volume, CH_4, 36; heavy hydrocarbons and benzol, 4; CO, 8; CO_2, 2; N, 2 to 3; sulphur, in all forms, from 304 to 347 grains per 1000 cu. ft. When such a mixture as this is burned, the products are, along with a little nitrogen, carbonic acid and water vapor, with some sulphurous acid, which soon becomes sulphuric acid in damp air, and also traces of nitrogen-oxygen compounds, which experiment has shown to be always produced in every case of combustion in atmospheric air. "Imperfect combustion may lead to the formation of other products. Then there may possibly be other constituents in coal gas, not usually sought for, or difficult to detect; and these, though not affecting the heating or lighting value, might be hygienically of importance; for instance, arsenic might possibly be present. To hunt out every possible component of the products of combustion by itself would be an endless task. But the problem became a simpler one when once it was ascertained that in good ordinary burners combustion is complete; and the question became practically one for carbonic oxid, arsenic acid, hydrocyanic acid, ammonia, and nitrous acid and other oxygen-compounds of nitrogen."

The experiments were made with "the ordinary slit burner, the argand burner, and the Welsbach burner." It is easy to collect the products of combustion from either of these types of burners. The chemical tests applied for the analysis of these products would interest only chemists. We shall review only the results. With both the slit burner and the argand burner "no volatile, neutrally-reacting, unburned compound of carbon, such as hydrocarbon or carbonic oxid, is liberated on combustion." With Welsbach burners some carbon in the form of hydrocarbons and carbonic oxid does get through; and this was found to be uniformly the case under all the conditions by which it was sought to prevent their occurrence. The quantities of these products were, however, so small that by no conceivable possibility could they become harmful. We may, therefore, consider all these types of burners, when in good condition, as perfectly innocuous so far as generation of carbon compounds is concerned.

The only volatile acids found were carbonic and sulphurous acids. A special search for hydrocyanic acid gave only negative results, and not the slighest trace of arsenic was detected. The sulphurous acid was also considered to be so small in quantity as theoretically not to be in any degree noxious; but, to make assurance doubly sure, the chemical tests were followed by physiological tests on small animals (mice), which breathed for 3 days the atmosphere containing the products of combustion without any signs of discomfort. The blood of these animals, upon analysis after such exposure, showed no traces of the absorption of harmful products. Experiments of Mr. Novik, at the Christiania gas-works, have proved that, "if there be no escape of gas, and if the burners be steatite and not of iron, the growth of plants in a room lit by gas is unexpectedly good. In fact, a fine floral display has been maintained in the gas-lit offices of the Christiania gas-works."

Ventilation and Heating of Schools.

In a paper on the above subject by Professor O. L. Miller, read before the Sanitary Convention last November, and reprinted in *Architecture and Building*, the author maintains that 2000 cu. ft. per hour for each pupil should be supplied. This amount is advocated at the present time by the highest authorities on school hygiene. Of course this amount is to be supplied in summer as well as in winter; but in winter the air-supply will require to be warmed before being forced into the apartment to be ventilated. Professor Miller is an advocate of downward ventilation, and he gives the following reasons for his preference. "If, however, nature has found it wise to place barriers to dust at the entrances of our bodies, is it not worth while to assist her? This principle leads us to place the outlets at the floor level, and the inlets in the wall several feet from the floor. Two other objects are also accomplished. The inlets do not collect as much dust as they would if placed in the floor. The air is taken from the floor, where the air is longest in the room and therefore the most impure air collects. Second, the air in contact with the windows and outside walls being cooled most rapidly, we should place the outlets near those walls; otherwise currents of cold air may be noticeable near the floor."

The fact that it is unsafe to regard two rooms as equally ventilated because they have the same areas of inlet and outlet cross-sections is pointed out. This error is not unfrequently made. The distance the air must move in the flues, the form of the flues, and the number of bends in the passage will, independently of the area of cross-section, greatly influence the flow.

"Undoubtedly the most frequently violated and at the same time the most important principle is that the outlets from each room should open into separate ventilating shafts. Adherence to this principle is absolutely essential to satisfactory ventilation. If several rooms ventilate into a common shaft, the moment the equal pressure of air in those rooms is destroyed, as by the opening of a window, that moment there is danger and probability, not only that the foul air from some of those rooms will not be drawn out at the usual rate, but that foul air from this common shaft may be actually forced into some of the rooms. The common ventilating shaft may in this way be the means of spreading disease germs from one room to another."

The best systems and apparatus for ventilating may fail of efficacy through faults in management. "It is quite generally recognized that the outlets are not to be closed, but it seems to be forgotten that the closing of the inlets cuts off our supply of fresh air. It should be impossible to close the inlets. Protection from too high a temperature should be secured in two ways. First, the janitor should exercise care and judgment in the control of fires. Not precisely as hot a fire should be built on a mild spring day as on a cold winter day. Second, there should exist an arrangement, under the control of the teacher, of such a nature that cold fresh air could be admitted directly into the warm-air inlet pipe. Thus the volume of fresh air entering into the room is not diminished, but its temperature is lowered."

In conclusion, all direct heating in school-rooms, whether by steam or hot-water, is condemned. Indirect locating should always be employed.

An Alleged Remarkable Discovery in Gas.

THE substance of the following statement, which, until it is further confirmed, had, perhaps, better be taken with some grains of allowance, is made in *Domestic Engineering* for August. It relates to an alleged French discovery in gas-lighting, which, it is claimed, places the latter in a position to compete with electricity without any reservations, and which is said to be the invention of M. Denayrouse, a French scientist. The new method, it is said, was exposed by M. Mallet at a recent meeting of the Société Technique de l'Industrie du Gaz. In making the invention "M. Denayrouse had first been struck with the idea of applying the principle of the blow-pipe to the gas burner; and, instead of increasing the heat, he sought to increase the lighting power. He employed a lamp with a spherical-shaped metallic body and an incandescent mantle. In the body of the lamp is placed a very small dynamo working a ventilator and receiving the current from a couple of tiny accumulators. The electrical energy generated is exceedingly small, and is only about one-third volt and one-tenth ampere. This, however, is quite sufficient to force a current of air through the mantle, and to cause the gas to burn with remarkable brilliancy. M. Mallet then lighted the lamp, and the result was so surprising that the members broke out in cheers."

"The lamp," said M. Mallet, "has a power of thirty-five to forty carcels, and the lamp consumed 7 liters of gas per carcel." He had, however, been shown a lamp of eighty carcels, and he was convinced that it was quite as brilliant as the arc lamps, few of which attained this power. For lighting open spaces he thought that the time was not far distant when gas would entirely supplant electricity, and the arc lamp would have to come down from its high pedestal.

Instead of enemies, gas and electricity would be sisters. In the electrical cables and gas conduits of the cities there was enormous illuminating energy hitherto unsuspected. As to the practical character of the lamp he would say nothing until he had had an opportunity of putting it to the test, but he could now say that the lamp was very simple of construction and very safe to use. The suppression of the glass was quite unexpected, even to himself. M. Denayrouse was warmly complimented by the members for his remarkable invention. The carcel lamp here referred to is named from its inventor, M.

Carcel. It supplies oil to the wick by a small pump operated by clockwork. A form of this lamp, in which a ventilator is operated by clockwork, thus supplying draft without a chimney, was put on the market, in the United States a few years ago.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Heating and Ventilation.

698. Ventilation and Heating of Schools. Extract from paper by O. L. Miller (General movement of the air should be downward; Outlets near outside walls; opposed to heating by direct radiation). Arch & Build–Aug. 10. 1600 w.

*867. Failures of Heating Boilers (Editorial review of Board of Trade report on failures during winter of 1894–5). Prac Eng–Aug. 9. 1400 w.

914. Low Pressure Steam Heating Apparatus. Ill. James Mackay (One pipe gravity return). Mas Steam Fit–Aug. 1000 w.

915. Drainage of Heating Coils and Steam Pipes in Sugar Houses. Allahassett in La. Planter (Means principally used; suggestions, etc). Mas Steam Fit–Aug. 1900 w.

966. Heating in a Washington Residence. Ill. (Diagrams of plans; method of computing heating surface, etc). Eng Rec–Aug. 24. 1200 w.

968. Heating Notes and Data (Extracts from a report of J. H. Kellogg, M. D. to the Michigan State board of health. A résumé of important and essential points to be observed to secure successful results in heating and ventilation). Heat & Ven–Aug. 15. 1500 w.

970. Heating with the Open Fireplace. Will Walter Jackson (Only about 10% of heat is received in the room). Am Arch–Aug. 24. 800 w.

1256. Calculating Chart for Area of Indirect Ducts; and Effective Area of Registers. J. L. Bixby, Jr. (With explicit explanation and directions for use). Met Work–Sept. 7. 700 w.

1273. The Jefferson Hotel, Richmond, Va. (Detailed description of the heating, water supply, steam power, and electric lighting plants). Eng Rec–Sept. 7. 3300 w.

Landscape Gardening.

766. Color in the Garden. Editorial (Deals with the color schemes of beds and borders). Gar & For–Aug. 14. 1400 w.

909. Covered Ways of Hardy Fruit Trees. Ill. (Cultivation of trees for shade as well as fruitage). From The Garden. Sci Am Sup–Aug. 24. 500 w.

1015. The Treatment of Small Seashore Places. Editorial (Simplicity the quality desired). Gar & For–Aug. 28. 1300 w.

†1043. Aquatic Gardening. Ill. J. H. Connelly (Water-plant culture for the estate, the garden, and the house). Cent Mag–Sept. 6000 w.

1196. The Architectural Attack on Rural Parks (Extract from letter by Frederick Law Olmstead, with editorial comments). Gar & For–Sept. 4. 1200 w.

Plumbing and Gas Fitting.

*773. A New Incandescent Gas-Lighting System (Ver-Stracten's System. Descriptive). Jour Gas Lgt–Aug. 6. 900 w.

*872. Sanitary Plumbing. Ill. Cesare J. Marani (Lecture delivered before the Eng. Soc. of the School of Prac. Science, Toronto). Dom Eng–Aug. 2400 w.

*873. A Remarkable Discovery in Gas (Describes a combination of a gas-burner and mantle with a small dynamo in the lamp for supplying air for combustion). Dom Eng–Aug. 500 w.

*874. Antiquated Plumbing (Criticises the retention of antiquated plumbing in city public buildings, and sets forth the obstacles which prevent introduction of modern improved methods and appliances). Dom Eng–Aug. 1300 w.

906. Plumbing a Tall Office Building (Complete specifications for the plumbing of the 25-story building of the American Tract Society in New York). San Plumb–Aug. 15. 8500 w.

965. English Views Concerning Main Traps on House Drains (Abstract of a report by T. de Courcy Meade, engineer of the local board of Hornsey, one of the suburban districts of London, approving the use of such traps). Eng Rec–Aug. 24. 2500 w.

1125. The Flow of Gases and Proportioning Gas Mains (Original diagrams with explanatory notes, etc). F. S. Cripps. Pro Age–Sept. 2. Serial. 1st part. 700 w.

*1224. Incandescent Gas Lighting (An account of an interview with Julius Moeller, inventor of the system improved by Welsbach, relating to the past, present and future of incandescent gas lighting, with a portrait of Moeller taken by Welsbach light). Gas Wld–Aug. 31. 2800 w.

1258. Modern Bath Rooms (Describes a number of luxurious bath rooms in the most recent examples of costly residences erected in the United States). San Plumb–Sept. 1. 800 w.

Miscellany.

*871. Selling Hot Water. Ill. (System in vogue in Paris). Dom Eng–Aug. 600 w.

*1002. The Best Way to Burn Gas for Lighting Purposes. C. R. Bellamy (A very instructive lecture to users of gas, pointing out the practical economies possible in the use of gas for illumination, and showing how the same amount of illumination may cost more to one consumer than to another, through neglect of due attention to these practical economies). Gas Eng Mag–Aug. 10. 2800 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading and Domestic Engineering.

The Wiring of Buildings.

In the *Electrical Engineer* (Aug. 7) A. E. Dobbs has a very suggestive and valuable contribution, in which the merits and demerits of different methods of interior wiring and wire-protection are discussed. He points out that the weak spots in all wiring systems, both as to insulation and resistance, are to be looked for at the outlets. In a long experience he has observed but very few instances of trouble in the runways. The loop system is objectionable because there are four wire-ends to deal with at each outlet instead of two, and hence there is great liability to the introduction of an abnormal increase of resistance by reason of neglect of proper soldering. Theoretically, the interior conduit system is a good one; but, as the author pertinently remarks, "there is no use arguing what the system would do if properly installed. The most specific directions and lectures as to the proper mode of installation will not help a careless wireman, or alter the financial aspects of the case to a contractor who has been compelled to 'figure close,' and who tries to save all he can on the labor account." While highly commending the modern iron-armored conduit for all first-class work, Mr. Dobbs suggests a plan for the cheap and safe wiring of wooden houses of moderate cost, such as are found in most towns and villages in the United States, which appears to possess merit. Weather-proof triple-braided wire, saturated with asphaltum compounds which mice will not meddle with, has been found to give good service in this class of work, though sometimes objected to by insurance inspectors. The wires are run through the central openings of ordinary porcelain knobs stapled or tied to the joists and studding, porcelain bushings of ample size being used in passing through timbers. At the outlets, porcelain tubes with at least a 3/8-in. hole are employed, both wires of a loop being pulled through the same tube. The wires are drawn through from one outlet to another, as in the conduit system. The matter of the inexpensive and at the same time safe wiring of small houses is an important one, and we are glad to note that some attention is being given to it by well-qualified experts.

The Chicago-St. Louis Air Line.

As long ago as May, 1893, in commenting in this department on the extensively circulated prospectus of the Chicago and St. Louis electric air-line, we remarked that it had always been impossible for electrical men to regard the project seriously, and that the undertaking did not appear to be founded upon anything substantial, unless it might be human credulity. The general public, and even many of the technical journals,—which ought to have known better, and, in fact, did know better,—were apparently unable to see anything in the least out of the way in the offer to sell a stock, alleged to be absolutely certain to earn 29 per cent. (exact figures) per annum, at 60 per cent. of its par value. Now, to use an expressive colloquialism, it appears that the scheme has "gone up," although it is only a few weeks since the chief promoter of the swindle announced that nine out of the ten million dollars needed to complete the road had been raised, and that, inasmuch as "the bankers were under a constant daily forfeit to raise the balance, the ultimate success of the enterprise was assured." *Electricity*, which, like The Engineering Magazine, has not failed to tell the truth about the scheme, in its issue of July 24 says that "the episode now ended may seem to the superficial like a huge joke. It is nothing of the kind. Several hundred people who have bought stock and lost their money will forever associate all electrical investments with the great Chicago-St. Louis Air Line. And why should they not?" Nearly all the other electrical journals treated the matter seriously, and discussed it as if there was really something in it. But there are plenty of other electric railway schemes at this moment appealing to the public for capital which are not one whit better, intrinsically, than the defunct air-line, the promoters of which have collected and dissipated $112,000, according to newspaper accounts.

Poles, Wires, and Shade Trees.

ACCORDING to an editorial in the *Electrical Engineer* (Sept. 4) the electrician of the Detroit municipal lighting commission has officially denounced shade-trees as a "nuisance." "They not only shut out the electric light, but God's own sunshine." "Their stems are stubby, and their foliage is a clumpy sponge." "It is difficult to get wires or lamp-posts under them, but the illumination from towers cannot penetrate downwards through their black masses of summer foliage, while in winter their bare arms are constantly breaking and falling upon the streets, the houses," —and last and worst of all—" upon the circuits." As if this were not quite enough, the editorial writer adds, as a result of his own observations, that " they harbor noisy sparrows and hairy caterpillars that are always dropping down one's back," and hence he agrees with the municipal electrician that "the shade-trees need regulating more than the poles and wires do." We must confess to a mild feeling of surprise that our editorial brother admits that the "glorious avenues of Easthampton" are the "pride of every artist." Can a tree with unsymmetrical straggling branches irregularly dotted with chestnut burrs and other like excrescences bear a moment's comparison, from an artistic point of view, with an electric-light pole, with its equidistant and parallel cross-arms and its vivid green-glass insulators in serried rows glistening in the sunlight? Does not every scientific mathematician regard the catenaries in which ropy-looking wires of various shades of white, gray, and black are festooned from pole to pole as examples of the most beautiful curves in nature? And, pray, when did nature ever produce anything in the way of a parasitical fungus which could bear a moment's comparison with a Thomson-Houston transformer? The shade-tree must go! There are no shade-trees in Timbuctoo, and yet we prate of our advanced civilization.

Electric Railway Problems.

THE New Orleans *Times-Democrat* of recent date contains a very interesting discussion of the above subject by Oscar T. Crosby, a well-known authority in electric transportation matters, the substance of which may be found in the *Electrical Engineer* (July 17). Mr. Crosby's views as to the introduction of electricity in place of steam in heavy railway service do not differ materially from those expressed by Mr. Sprague in a recent paper published in this magazine; that is to say, he thinks that the real question as to the advantageous use of steam or electricity on any given line is practically solely one of frequency of service. He expresses the opinion that the existing railway service between New York, Philadelphia, and New Haven, and on the New York Central as far out as Yonkers, might even now be performed by electricity at a cost slightly less than by steam. For rapid transit service he believes that there is no longer any question of the superiority of electricity, not alone on the score of economy, but on those of increased cleanliness and diminished noise. " For all classes of service," says Mr. Crosby, "electric locomotives offer one advantage over steam which the world will more and more learn to appreciate,—that is, very high speed. . . . All well-informed experts are agreed that nothing save the inertia of capital now lies between civilization and a transport speed of 150 miles an hour. It is probable that the earliest line on which such high speeds will be regularly adopted will be that between New York and Philadelphia."

Self-Propelling Road Vehicles.

THE *Electrical Engineer* (July 24) gives some particulars in reference to the recent competitive trial of self-propelling road carriages between Paris and Bordeaux, with illustrations of some of the vehicles and a graphic chart showing the different runs. The results of this trial make it clear that for this class of work electricity must hereafter be regarded as out of the race. To produce 1 h. p. for 1 hour requires only 0.88 lb. of gasoline, while at least 6.6 lbs. of coal, or 220 lbs. of storage battery, are necessary to do the same work. In its editorial comments on the results of the competition the *Electrical Engineer* hazards the observation that " the conclusion is unavoidable that for long distances, such as those covered by the Paris-Bordeaux contest, the electric storage-battery carriage is not yet available." But for shorter distances, in which "comfort is the first consideration," the writer has no hesitation in saying that the comparison between the storage battery and motor and a heat-engine of any kind is almost ludicrous. " Far, therefore, from losing courage," says this writer, " those who are devoting their attention to the construction of electric carriages should redouble their efforts." We cannot concur in this advice, however well-meant it may be. The *ignis-fatuus* of storage-battery traction marks the position of a bottomless sink-hole into which millions of dollars have been poured during the past 15 years, with results which thus far, and as far as the eye of the expert can discern in the future, are not merely discouraging, but absolutely hopeless. With the advent of a system of improved highways, the general use of mechanically-propelled vehicles must almost necessarily follow, but that they will be driven by electric power in any form is most unlikely, and that the source of power will be a storage-battery must be regarded as the wildest of improbabilities.

Electrically-Lighted Channel-Buoys.

THE lighthouse board have recently completed a permanent plant for lighting the main channel leading into the harbor of New York, as a result of experimental work commenced some time since, and which has proved in most respects very satisfactory. The *Electrical Engineer* (July 31) contains an illustrated description of the plant and a map showing the location of the lights on each side along the channel. The generating station is on Sandy hook, and sends an alternating current of 1000 volts through a submarine cable having a total length of 32,660 ft. The buoy lamps are incandescents of 100 c. p. enclosed in glass globes, and are fed by small transformers in water-tight cases, which reduce the potential at the lamp terminals to 100 volts. The effect of the brilliantly-lighted water-lane, when seen from the deck of a transatlantic steamer, is a novel and attractive one, while its practical value is so apparent that it need not be enlarged upon. The whole work has been intelligently designed and well-executed, and may be said to mark a distinct advance in electrical engineering.

The Storage Battery as a Motive Power.

WE still hear of renewed attempts to introduce the storage battery as a motive-power for street-cars. It seems as if investors might learn, after a while, to throw no more good money into such a bottomless sink-hole.

One of the most persistent attempts to work cars by storage-batteries has been made by the Birmingham (Eng.) Central Tramways Company, and some of the latest results are given in the *Electrician* (Aug. 30). Last year the chairman graphically described the situation as one of " mingled difficulty and hope," a very restrained dose of prophecy for a chairman, seeing that a *bona-fide* profit of over £1200 had actually been earned by the accumulator cars for the first time in history. Unfortunately his successor this year was compelled to chronicle a loss of £1735,—attributable, of course, not to the system of traction, but to bad weather, fire at terminus, and omnibus competition. The figures presented showed that, while the mileage had remained stationary, the receipts had decreased 6 per cent., and the expenses increased 27 per cent., the total cost per car-mile having grown from 14¾d. to nearly 18½d. The exact figures of the cost of the four different systems employed by the company per car mile are as follows : cable, 5.43d. ; horse, 8.67d. ; steam, 9.11d. ; storage batteries, 18.43d. No wonder one of the directors was led to exclaim that "he had come to the conclusion that, so long as they worked this line by the accumulator system, so long would they have a millstone round their necks which would drag them to the ground."

The *Electrician* says: "It is not considered particularly chivalrous to strike a man when he is down, and, acting up to this laudable tradition, we will not duly enlarge upon this matter. Suffice it to remark that the Birmingham line is not an abnormally trying one, that several types of cell have been employed, and that these experiments on a commercial scale have now lasted several years. And yet there are individuals who affect to believe in electric omnibuses."

Measuring the Velocity of Projectiles.

IN the *Electrical World* (Aug. 10) A. C. Crehore and G. O. Squier describe a series of tests conducted with a new instrument for measuring the velocity of projectiles, made by them at the artillery school at Fortress Monroe last January. The superiority of the particular instrument employed resides in the fact that, in recording the effect of a variable current of electricity, no ponderable matter is required to be moved, as in the case of the instruments heretofore employed for this purpose. As many as ten observations were obtained at regular intervals of 5 ft., beginning at the muzzle of the gun and extending to a distance of 45 ft. From measurements on the photographic negatives it was clearly demonstrated that the velocity of the projectile actually increases after leaving the gun,—a fact which had long been suspected, but never before experimentally demonstrated. The apparatus depends for its action upon a beam of polarized light which registers itself upon a moving photographic plate. The direction of the ray is controlled by a variable magnetic field. Full details of the apparatus and results are given in the paper, which is one of unusual interest.

Induction in House Wiring.

IN a letter to the *Electrical World* (Aug. 10) Mr. W. M. Venable calls attention to the deleterious effects of induction due to running the direct and return wires of an alternating circuit in separate iron tubes, instead of placing both in the same tube, as good practice dictates. He mentions in particular a case of a church building, wired throughout in this way for a 52-volt secondary distribution, in which the inductive drop proved to be so excessive that there was not sufficient potential at the lamp-terminals to enable the voltage to be read on an instrument, and it was actually found necessary to tear out four-fifths of the iron pipe, and insert condensers to overcome the effect of that part of the pipe embedded in the walls which could not be reached without pulling them down. Mr. Venable observes that this method of installation only serves to defeat the very purpose for which iron pipe is employed,—that of making the work fire-proof. If, for instance, a wire becomes grounded in each pipe, wherever the pipes may come in contact an arc is liable to be formed which may easily set fire to the building, whereas, when both wires are in the same pipe, the effects of an accidental short circuit must be confined within it, and, if the pipe has sufficient thickness of metal, no such danger need be apprehended.

Freight Traffic on Electric Railways.

WITH the rapid increase of suburban and inter-urban electric railways, a considerable demand has arisen for facilities for carrying freight, express, and mail matter, and a number of special types of motor-cars have been designed and constructed for this particular service. The *Electrical Engineer* (July 17) gives a *résumé* of the progress which has been made in this direction in different parts of the country with illustrations of some of the vehicles used. Apparently the favorite type for this service is a "combination" car, provided with separate compartments for passengers and freight. In many instances such a car is provided with motors sufficiently powerful to enable it to act as a locomotive and to haul one or more trail-cars. The article gives many interesting particulars of the special features of the equipment of a number of roads in different parts of the country which have undertaken to carry merchandise as well as passengers. Undoubtedly this can be done in very many instances greatly to the profit of the undertakers, and to the convenience of the general public. Postal-cars are also rapidly being introduced on the street-railway systems of the principal cities, and are found to greatly expedite the collection and delivery of the mails.

Transformer Economy.

THE results of a carefully conducted test of commercial transformers by A. H. Ford of the University of Wisconsin is given in a paper read by D. C. Jackson before the Northwestern Electrical Association, published in the *Western Electrician* (Aug. 24). The table in which the results are summarized shows, as might have been expected, that in most cases the transformers with the smallest iron loss give the highest all-day efficiencies. A comparison of two transformers of leading commercial types, in which the copper loss was substantially the same, showed that one consumed in its operation something like 3 per cent. more current than the other, while, on the other hand, the self-regulating properties of the latter were considerably better than those of the former. The conclusion reached is that the copper losses in transformers of all sizes should never exceed 3½ per cent. at full load, and ought to be kept down to between 1½ and 2½ per cent., while the total drop in potential in the secondary due to full load, if the primary is kept constant, ought not to exceed 3½ per cent. The testing of each individual transformer before being placed in circuit is strongly recommended, and it is shown that this may easily be effected by means of a wattmeter and volt-meter, with which every central station should be supplied.

Modern Power Transmission.

THE London *Electrical Engineer* (Aug. 16) publishes an interview with Mr. C. E. L. Brown of Switzerland, an engineer who planned many of the earliest of the successful power-plants in Europe, which contains some statements of interest. Mr. Brown prefers the single-phase alternating system of distribution in cases in which the principal demand is for lighting and the motor service comparatively unimportant; if the call for power and light is approximately equal, the two-phase is better, while he always adopts the three-phase system in cases in which the power-supply largely predominates. He commends the practice, followed by the Stanley company in this country, of furnishing directly from the generator all potentials up to and including 5000 volts; this pressure is ample for all distances up to 10 miles. For small motors he employs a reducing transformer, although he has constructed one 5000-volt motor of 110 h. p., which has been running successfully for over a year. His estimate of the average cost of hydraulic works including turbines, is from $160 to $200 per h. p. of output; for the generating plant, including switchboard apparatus, $20; for the line, anywhere from $10 to $20 per h. p.; making a total of, say, $220 per h. p. He advises the use, in direct current installations, of multipolar machines in all sizes above 50 k. w. of output.

The Unit Fever.

A VERY lively and entertaining correspondence is going on in the columns of the British technical journals, especially the *Electrician*, anent a new series of units relating to magnetic values which has been proposed by some of the learned gentlemen to whom one correspondent irreverently refers as "the scienticulists of the B. A." The practical dynamo builders do not seem to be impressed with the necessity of introducing so many additional units, although one of them admits that he always thinks of the proposed "thom" as "a unit of squirming in the ether." Another constructor says that engineers have heretofore got on very well without any unit of lines of force, and thinks that it would be no more useful than to coin a new word for "one revolution" and another for one thousand revolutions,—a kilo-revolution, to wit. Still another constructor observes that "conversions of the dimensions in a design from centimeters into inches are a serious nuisance, which an engineer cannot afford to submit to merely in order to support a theoretical system of measurements." Up to date, it looks as if the "practicians" had rather the best of the argument, so far as magnetic units are concerned.

Electric Traction at the Railway Congress.

THE London *Electrical Review* (Aug. 30), speaking of the report on the general question of electric traction presented to the late International Railway Congress, characterizes it as "deplorably weak," and thinks that it has little to commend it to the serious attention of railway engineers beyond a very ample discussion of the Heilmann locomotive. Much space is devoted to the consideration of such obsolete devices as chain-gear and double-reduction motors, while the recent successful applications of high-tension alternating currents transmitted from a distance and transformed at a sub-station into continuous currents are not so much as mentioned. It would seem, also, as if some detailed account might have been given of such important and interesting applications as those recently made by the Baltimore & Ohio Company and the Chicago elevated railway. However disappointing the report may be, the *Review* nevertheless regards it as a good sign that the subject should have received some attention during the deliberations of the congress, and trusts that another year it will be more fully and practically treated.

Incandescent Street Lights.

REFERENCE was made in these notes last month to a paper by George Cutter advocating the use of the incandescent rather than the arc lamp for street lighting. This paper was followed by an interesting discussion, which is reported in the *Western Electrician* (Aug. 24). One speaker admitted that, if the end in view was to make a display of luxury, arc lamps were, of course, preferable, but that he could supply ten 16-candle incandescents for the price of one arc, and give much better service. In Beaver Dam, Wis., the incandescent lamps are placed so as to illuminate the sidewalks rather than the street; as one speaker said, horses don't need a bright light. Another speaker said that in Racine, Wis., arc lamps of 1200 nominal c. p. had been substituted for the 2000 c. p. arcs formerly used, and that not one of the citizens ever noticed the difference, which leads one to think that they must have always looked at the lamps, and not at the illumination produced in the streets. The general opinion of those participating in the discussion appeared to be that the present tendency in street-lighting is towards the liberal use of incandescent lamps, supplemented in some cases with arc lamps in the business districts, to be used only during business hours in the evening.

The Liverpool Electric Railway.

THE London *Electrical Review* (Aug. 16) contains a report of the operations of the above-named line for the past half year, from which it appears that the enterprise is proving a very successful one. During the 6 weeks which had elapsed since June 30, the number of passengers carried showed an increase of 55,000, and the receipts were £1668 more than those of the corresponding period of last year. The receipts for the half-year averaged 1.92d per passenger. The physical condition of the structure was never better than at present. An extension of the line to the southward had been contracted for, and would be completed within a year, which would undoubtedly bring a large accession of traffic. Dividends were recommended of 2¼ per cent. on ordinary shares and 5 per cent. on preference shares.

Non-Magnetic Electric Devices.

UNDER the above title, Mr. W. E. Irish, in the *Electrical Engineer* describes a large number of typical mechanical devices and movements where the electro-magnet, which has heretofore formed an essential part, has been replaced by an electro-thermal conductor, producing motion by its alternate expansion and contraction during the process of heating and cooling. Mr. Irish lays down the following somewhat startling proposition,—*viz.*, "if it is a fact that a straight wire, measuring perhaps but a few inches in length and offering comparatively no resistance or counter-electromotive force as compared with an electro-magnet, will give the same result with fewer parts, greater simplicity, and higher economy, then there should be no objection to the relegation of the electro-magnet to the antiquarian's cabinet." He then proceeds to show by diagrams how some twenty or more devices in common use, among which may be mentioned telegraphic instruments, electric bells, telephones, regulators, etc., may be operated in this way. Mr. Irish has certainly cultivated with some advantage a very much neglected field of research, and some of the results he claims to have obtained, if well founded, cannot but prove valuable and important. At all events, the paper is a most suggestive one, and will serve to direct attention to the inviting possibilities of the subject.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Electricity in the American, English and British Colonial Technical Journals—See Introductory.

Lighting.

734. Selection of High-Speed Engines for Electric Lighting. Fred W. Richart (It is the purpose of this article to point out details of design and construction that are desirable and those to be avoided). Elec Wld–Aug. 10. 3400 w.

749. Tests of Incandescent Lamps (Prof. B. F. Thomas' tests of the Packard incandescent lamps, the object of which was to determine candle-power and efficiency at suitable intervals during a period of at least 600 hours). Elec Wld-Aug. 17. 1800 w.

*833. Horizontal Carbon Projectors. Ill. E. A. N. Pochin (Tests of the Crompton automatic and hand-feed lamp, with description). Elect'n–Aug. 9. 1000 w.

893. Buffalo Bill's Portable Electric Light Plants. Ill. Frank B. Widmayer (Descriptive). Elec Eng–Aug. 21. 1000 w.

*924. Refuse Destruction as Applied to Electric Lighting Purposes, (Practicability of.) Ill. E. Manville (Paper read before the Hull Congress of the British Inst. of Public Health). Elec Eng, Lond–Aug. 16. 3500 w.

*958. The Electric Lighting Plant at Victoria Station, L. C. and D. Railway. Ill. W. D. & S. R. (A detailed description of one of the oldest plants in England). Elec, Lond–Aug. 16. 2000 w.

*991. Dust Destructors and Electric Lighting. — Shoreditch (Descriptive). Elec Rev, Lond-Aug. 16. Serial. 1st part. 1500 w.

*992. The Edinburgh Corporation Electricity Works. Ill. (Two distinct and separate systems of supply under one roof). Elec Rev, Lond-Aug. 16. 4000 w.

*993. Interesting Effect Observed With the Voltaic Arc. Albert Nodon in L'Electricien (Due to arrangement of reflector). Elec Rev, Lond-Aug. 16. 1100 w.

*1057. Notes on Experimental Investigations of the Arc. Ill. W. H. Freedman (A short history of procedure which finally resulted in separating by actual physical measurements the counter electromotive force from the resistance). Elec Pow–Sept. 1500 w.

*1059. Electrically Lighted Buoys. Ill. Ira W. Henry (Historical and descriptive). Elec Pow–Sept. 2500 w.

*1289. The Localization of Earth Faults in Electric Light Circuits. J. Pigg (Mathematical with diagram). Elect'n–Aug. 30. 500 w.

Power.

*701. Notes on Hydraulic Power Supply in Towns—Glasgow, Manchester, Buenos Ayres, etc. Edward B. Ellington (General arrangement, boilers, accumulators, mains, efficiency, etc). Elec Eng, Lond-Aug. 2. 4500 w.

*731. Traction by Accumulators. Ill. (Regards success as still doubtful, but thinks recent experiments in Paris give hope that difficulties will be ultimately surmounted. Describes accumulator cars apparently successful in Paris). Elec Rev, Lond–Aug. 2. 1200 w.

*737. Electric Mining Locomotive. Ill. (Descriptive). Ry Wld–Aug. 700 w.

895. Power Plant Economics, J. W. Greer. (Practical and valuable suggestions). St Ry Rev–Aug. 3300 w.

896. Overhead Construction in the Baltimore and Ohio Tunnel. Ill. (Descriptive). St Ry Rev–Aug. 600 w.

*925. Electrical Haulage at Earnock Colliery. Ill. Robert Robertson (Descriptive of colliery generating plant, electrical hauling engines, working, haulage cables, pumping, &c). Ind & Ir–Aug. 16. 2500 w.

*1044. Electric Motor Drives a Cable Plant. Ill. (The first of its kind. Descriptive). St Ry Rev–Aug. 15. 800 w.

1055. Additional Solutions of the Electrolytic Problem. Ill. Arthur V. Abbott (Expedients which have been proposed, affording more or less partial solutions of the problem). W Elec–Aug. 31. 1200 w.

*1060. Calculations of the Weights of Accumulators Required for a Railway. G. Chevet and H. Boy de la Tour (Mathematical). Elec Pow–Sept. 900 w.

†1087. The Electric Railway of Milan, Italy. Ill. (Plant installed on the Edison system). St Ry Jour–Sept. 1200 w.

1126. Western Avenue Power Station of the North and West Chicago Street Railroad Company. Ill. (Description of plant). Power–Sept. 500 w.

*1148. Electric Railways in Maryland (Maps of electrical railways into and in Baltimore and connection with Pennsylvania lines, with a discussion on their utility). Am Eng & R R Jour–Sept. 2700 w.

*1175. Nikola Tesla and the Electrical Outlook (The new development in power transmission). Rev of Rev–Sept. 1800 w.

*1176. Industrial Niagara. Ill. Arthur Vaughan Abbott (Descriptive, with consideration of possible distance that power can be delivered in competition with steam). Rev of Rev–Sept. 1800 w.

1181. Some Applications of Storage Batteries. Ill. R. Macrae (Description of a few plants where the battery is used for work formerly done by primary cells). Elec Eng–Sept. 4. 2500 w.

1182. Electric Car Tests. Ill. Hermann S. Hering, assisted by Charles Reutlinger and B. Harrison Branch (These tests comprised a determination of the performance of electric cars of various kinds under definite conditions of load, speed, grade, track, etc., with a view to obtaining empirical data for these conditions which would at the same time have a fair degree of accuracy). Elec Ry Gaz–Aug. 31. Serial. 1st part. 2500 w.

1197. Economic Size of Feed Wires for Electric Railways. W. F. C. Hasson (Investigations and results believed to be sufficiently correct and easily applied to any particular case). Elec Wld–Sept. 7. 1000 w.

1198. The Choice of Transformers. D. C. Jackson (Read before the Northwestern Electrical Asso. Results of tests by A. H. Ford, with comparisons and data). Elec Rev–Sept. 4. 1700 w.

*1291. Tests of a Polyphase Motor. D. C. Jackson (Results of tests made on a three phase motor at the Univ. of Wis). Elec Eng, Lond–Aug. 30. 1000 w.

*1292. Light Railways and Tramways. R. H. Dorman (Light railways and tramways as constructed in Ireland). Elec Eng, Lond–Aug. 30. 3700 w.

Telephony and Telegraphy.

*690. Future of the Electric Telegraph. P. B. Delany (The possibility of mechanical transmission). Eng Mag–Oct. 4000 w.

*732. The Official Vocabulary of Code Words. From the London Chamber of Commerce Journal (A record of the steps which the London Chamber of Commerce has taken in the matter, and a summary of the arguments and criticisms which have motived its opposition to the adoption of the official vocabulary in its present form). Elect'n–Aug. 2. 2200 w.

748. The Telephone Monopoly and Subverted Patent Law. E. B. Frost (Argument to combat concession made to the Bell Company, maintaining that such concession is illegal in that it subverts the United States patent law). Elec Wld–Aug. 17. 4200 w.

751. Storage Batteries in Telegraph Work. Ill. (Its superiority, advantages, &c). Elec Eng–Aug. 14. 1300 w.

*882. The London Telephone Service. A. R. Bennett (Record of progress since 1892). Elec Plant–Aug. 1300 w.

889. Sending Pictures by Telegraph. Ill. (Method devised by W. H. Lowd, of Duluth, Minn). Elec Rev–Aug. 21. 800 w.

892. The Sabin-Hampton "Express" Telephone Switchboard System. Ill. (Descriptive). Elec Eng–Aug. 21. 1300 w.

*995. The Telephone in England. G. L. Addenbrooke (Comments on costs and table showing wages paid in continental countries and England). Elect'n–Aug. 16. 700 w.

1018. The Growth of Long Distance Commercial Telephony. Map (Comments and statistics from the last report of President Hudson, of the Am. Bell Telephone Co). Elec Eng–Aug. 28. 1800 w.

1021. The American Bell and Western Union Agreement of 1879 (First and full publication of the exact text of the famous compact of 1879, with editorial). Elec Eng–Aug. 28. 13500 w.

1022. Daily Insulation Testing of Telegraph Lines. W. H. Preece (Read before the Institution of Electrical Engineers. Description of method adopted). Elec Rev–Aug. 28. 1300 w.

Miscellany.

733. Measuring the Velocity of Projectiles. Ill. Albert C. Crehore and George O. Squier (Experimental tests of a new instrument). Elec Wld–Aug. 10. 3800 w.

760. The Capacity of Electrolytic Condensers. Samuel Sheldon, H. W. Leitch and A. N. Shaw in the "Physical Review" (Effect of electromotive force on capacity ; effect of electrode surface ; temperature ; coupling of cells, &c). Elec Rev–Aug. 14. 2200 w.

769.—75 cts. A Comparison of the Dissociation Values Calculated from Solubility Experiments and from the Electrical Conductivity. Arthur A. Noyes and Charles G. Abbott (1. Aim and principle of the investigation ; 2. Preparation and analysis of the salts ; 3. Methods of procedure ; 4. The experimental results ; 5. Calculation of the dissociation ; 6. The validity of the solubility principles ; 7. The electrical conductivity of the salts and the values of the dissociation calculated therefrom ; 8. The agreement of the dissociation values obtained by the two methods). Tech Quar–April. 3500 w.

*832. Lines of Force. W. G. Rhodes (A determination of the equation of a line of force due to any two poles, irrespective of magnitude and sign). Elect'n–Aug. 9. 700 w.

*836. The Invention of the Electromagnet (Criticism of article by M. Pellissier, by E. Boistel, in Revue d'Electricité). Elec Rev, Lond–Aug. 9. 2400 w.

*837. On a Low-Resistance "Dry" Accumulator. Desmond G. Fitz Gerald (Notes of experiments in connection with Fitz Gerald's system of working accumulators with an absorbed electrolyte, or converting them into so-called "dry" cells). Elec Rev, Lond–Aug. 9. 1400 w.

*838. The Magnetic Qualities of Forged Steel (Tests made by George O. Squier at the laboratory of the Johns Hopkins University). Elec Rev, Lond–Aug. 9. 1600 w.

*839. On the Use of the Quadrant Electrometer as a Differential Instrument. Riccardo Arno (Abstract from the Rendiconti of the Royal Lyncean Academy). Elec Rev, Lond–Aug. 9. 1000 w.

*848. The Potentiometer and Its Uses. Ill. Ellis H. Crapper (Because of the general application of the instrument in electrical measurements, the attention of students and electrical engineers is drawn to the principles applied, and to the construction and methods of using). Elec Eng, Lond–Aug. 9. Serial. 1st part. 1800 w.

*849. The Behavior of Transformers Under the Influence of Alternating Currents of Various Periodicities (Abstract of paper by Dr. G. Roessler, of Berlin). Elec Eng, Lond–Aug. 9. 1000 w.

912. On an Approximate Law of Magnetic Remanance in Iron and Steel. Edwin J. Houston and A. E. Kennelly (A diagram showing relation between remanance and maximum cyclic intensity). Elec Wld–Aug. 24. 600 w.

913. On the Use of Magnetic Formulæ in Electrical Design. Reginald A. Fessenden (Mathematical). Elec Wld–Aug. 24. 1600 w.

*994. A Graphical Method of Analyzing Harmonic Curves. E. Basil Wedmore. Elect'n–Aug. 16. 500 w.

1010. The Determination of the E. M. F. of Alternators. Ill. R. P. Brousson (The object of this article is to show how the E. M. F. of any alternator running on open circuit can be obtained, when the speed of rotation, the magnetic flux, and the shape and relative dimensions of the armature coils and field poles are known). Elec Wld–Aug 31. 1300 w.

1012. Tests of a Combined Electric Light and Electric Railway Central Station. Ill. Dugald C. Jackson and Arthur W. Richter (The tests described are of refined character and exhaustively include in their scope all parts of the plant). Safety V–Aug. 15. 4500 w.

1019. Researches on the Electric Discharge of the Torpedo. A. d'Arsonval (Abstract of a communication to the French Academy of Sciences. Lighting lamps and Geissler tubes). Elec Eng–Aug. 28. 1100 w.

1020. The Electric Furnace and Chemistry at High Temperature Ill. H. Moissan (What has been accomplished by means of this apparatus, and its operation. Its use in the working of metals). Elec Eng–Aug. 28. 1000 w.

1054. Compounding Dynamos for Armature Reaction with Converters. Ill. (Statement from Dr. W. P. Freeman). W Elec–Aug. 31. 700 w.

*1056. How Shall We Educate Our Sons for the Electrical Profession? Nelson W. Perry (An attempt to outline the general features, not the details, of the education which a young man should strive to attain if he aims to become an electrical engineer). Elec Pow–Sept. 4800 w.

*1058. Alternating Currents. Dr. Louis Bell (Paper read at Cooper Union, in connection with the Columbia College University extension). Elec Rev–Sept. 6000 w.

*1183. Action of the Electric Current on Aluminium Wires. Ill. (This article from La Nature is signed by Ch. Ed. Guillaume, but the first portion appears to be due to Prof. Margot). Elec Rev, Lond–Aug. 23. 1800 w.

*1184. Municipal Electricity. James Perry (Paper read before the Incorporated Asso. of Munic. and Co. Eng. at Londonderry. Its purpose is to assure municipal engineers that this new claimant of attention is in no way dangerous). Elec Eng, Lond–Aug. 23. 4400 w.

*1185. Unipolar Induction. Ill. C. L. Weber (Comments on the subject as treated by Prof. Lecher, with description of some experiments carried out by him). Elec Eng, Lond–Aug. 23. 1500 w.

*1186. Phase Difference in Alternate Current Electrolysis. W. R. Cooper (Experiments described by Herr Peukert with the object of investigating whether such phase difference does exist, with comments and brief reproduction of article by Herr Dolivo-Dobrowolsky). Elect'n–Aug. 23. 1700 w.

*1187. Electric Furnaces and Their Application to the Transformation of Carbon into Graphite. Ill. Ch. Street, with Editorial (Facts concerning early and recent types of electric furnace; review of the attempts that have been made in the direction of applying electricity to metallurgy; and description of methods for transforming carbon into graphite). Paper read before the Société Internationale des Electriciens. Elect'n–Aug. 23. 6500 w.

1274. Means of Preventing Electrolysis of Buried Metal Pipes. Ill. Isaiah H. Farnham, in Cassier's Magazine (The equi-potential return system recommended). Am Gas Lgt Jour–Sept. 9. 2500 w.

*1287. The Tin Chromic Chloride Cell. S. Skinner (Construction of cell. An interesting feature is that it may be used as the mechanism of a heat-engine for the production of work, and the complete cycle of Carnot can be traced in it). Elec Rev, Lond–Aug. 30. 600 w.

*1288. The Self-Induction of Armored Mains. J. Whitcher (A brief statement of the theory of the extra self-induction of conductors, due to iron armorings or surroundings, leading to some useful practical formulæ and approximations). Elect'n–Aug. 30. 2200 w.

*1290. On the Electrolysis of Gases. J. J. Thomson, with Editorial (Paper read before the Royal Society. Experiments and methods. Electrolytic transport of one gas through another. Polarization of the electrodes. Discharge through a compound gas, etc). Elect'n–Aug. 30. 7800 w.

INDUSTRIAL SOCIOLOGY

The Relations of Employers and Employed.

A GOOD contribution to current literature upon this subject is contained in an article written by Mr. Earnest H. Johnson and printed in *The Railroad Gazette* (Aug. 23). Mr. Johnson is connected with the management of the New York, Lake Erie, and Western Railway, and the methods of the management of that corporation in dealing with its employees are the burden of his paper.

First, as to selection of employees : the corporation is stated to be governed in this matter " largely by the law of supply and demand ; but, while this must always be the paramount consideration," Mr. Johnson thinks inquiry ought also to be made into past records of a man seeking employment, particularly if "the applicant has before been employed as a railroad man." As it is, " under the present system of taking men as they come and are needed, there is fostered a class of floaters (refuse generally from other remote systems), who are bad for the morale of the regular men and a source of expense and danger. A printed form of application should be used, covering all necessary qualifications as regards employment. Two stipulations are specially important: first, that the applicant shall be no more than 45 years of age, and, second, that he shall be able to read and write."

On the road in question, we are told, there are two schools for training new men,—a "train rule school" and " an air-brake school." But this is not thought sufficient. It is suggested that, in addition, the qualifications of railway employees should comprise at least such a knowledge of reading, writing, and arithmetic as would pass them through a primary department of a public school, though this suggestion is not made the basis of any recommendation as to the means of imparting such knowledge to railway men found to be deficient in it, other than that some facilities be afforded them for supplying the deficiencies.

The system of promotion which prevails on the railroad above named, in which "seniority is the governing factor," is criticised as being " absolutely pernicious." The criticism is justified as follows :

" No two men possess in equal proportion those qualities of energy, push, activity, good judgment, and general intelligence, the greatest combination of which in the greatest number is absolutely essential to best results ; and such a rule is absolutely untenable. It dwarfs ambition and individuality. By the very preponderance of mediocrity it leavens the whole lump, leveling down to that plane of second-rate abilities which any scheme based entirely on the mere longevity of the men is bound to foster. Such a system, moreover, fosters discontent and desire for change in young men of ability and energy, who feel that, however they do their work, their future depends almost wholly on the death-rate among their less active and energetic seniors. A system based on the service record of the men, coupled with recognition of exceptional evidence of good judgment and active energy in cases of emergency, would give much better results."

Supervision and discipline are administered on this road by the "train master, assistant train master, and yard master, and indirectly by the superintendent." The spirit in which the performance of these functions is enjoined, as set forth in the following quotation, is admirable.

" One of the first essentials for an ideal service is a willing one. For a willing service it is absolutely necessary, first, that the men shall respect a superior, and, second, that they shall have a personal liking for him. Respect can be engendered in no more effective way than by the evidence, on the part of an officer, of a perfect and comprehensive knowledge of the work done under and for him. And also by the enforcement (even to severity if need be), absolutely impartially, of punishments for infractions of or derelictions in duty. Nothing is more telling than a little of that fellow-feeling which makes us all kin. A courteous habit of at least listening to the real or fancied grievances of the men soon begets in their minds the conviction that, if a thing is worth having, it is worth asking for. And if these requests, when judiciously possible, are granted, a feeling of trust and confidence in the officer is fostered. Another potent promoter of zeal is a kindly forethought for the comfort of the men when exposed at wrecks. The writer has in mind a very forcible object lesson, where twenty men with 'full bellies' were worth forty half-fed and dispirited men.

"Punishment should be reduced to a minimum, and the past record of the offender taken into consideration. To do this with anything like completeness, a debit and credit system would have to be established. Minimize the publicity to disciplined employees, as it will largely do away with the humiliation arising therefrom. Never discharge a man where there seems a possibility for reform, but, once having discharged him, particularly for lying, continued drunkenness, and general unreliability, never re-employ him."

The system of premiums for service is spoken of as of doubtful utility. It apparently works well in some instances, and in others is a source of jealousy and disaffection. Probably the chief difficulty to be encountered is to secure impartial awards. On the Erie road there is a system of relief in cases of disability resulting from injuries received in the performance of duty; further than this there is no systematic provision for sickness, for superannuation, or for pensions. Mr. Johnson evidently regards such provisions with favor, notwithstanding current objections, and speaks commendingly of their institution and operation in Europe.

The Erie road has provided liberally for the comfort of its employees at terminals, by the establishment of libraries, reading-rooms, baths, and sleeping accommodations. The establishment of schools for technical training is also suggested as desirable.

Municipal Progress and the Living Wage.

WHY should not the adjustment of wages through free competition be permitted in the execution of municipal work? On what just principle can wages for municipal labor be fixed by law, that does not apply equally to all other labor? Ought not sound business methods to be adopted in the conduct of city affairs as much as in private affairs, or in the conduct of large industries? These questions, though not formulated in the above language, are, by implication, asked and in substance answered by D. McG. Means in *The Forum* for September.

The article begins with a reference to the experience of the past year in the department of street-cleaning in New York city under Colonel Waring's able administration, as "illustrating in the clearest way in which the illustration has yet been given the grave danger that besets the path of municipal government in the future." This illustration is both pertinent and peculiar. "When Colonel Waring took charge of the department of street-cleaning, he found that he was required by law to pay in wages nearly double what was necessary. He demonstrated that he could clean the streets properly for the amount appropriated, provided he could obtain authority to pay the rate of wages current in the market, and that he could give the laborers so employed steady work; or he could clean the streets imperfectly, paying the wages fixed by law, and giving somewhat irregular employment. But, if the city wished to have the streets kept clean at all times, while he was obliged to pay the legal wages, it would be necessary to have a much larger appropriation. The issue was most explicitly stated by Colonel Waring, and most carefully evaded by the city authorities. Violent attacks were made on him from various quarters, and at one time the press seemed about to abandon his cause. But the admirable condition of the streets was a weightier argument in his favor than any that could be brought against him, and at the last moment the city authorities yielded.

"But they did not yield on the matter of wages. They tried to see if expenses could not be reduced in every other direction, but the plain course suggested by Colonel Waring they most studiously ignored. And they were finally driven to strain the law in a manner which was shown by one of their own number to constitute a most dangerous precedent. The board of health is empowered, when sudden emergencies arise, such as the advent of pestilence, to call for appropriations of exceptional sums of money. It was pretended that, unless the system adopted by Colonel Waring was kept up in full perfection, the health of the city would be suddenly and seriously endangered, and by the aid of this transparent fiction an appropriation largely in excess of that provided by law was made available."

The reason for this attitude of the city authorities can be logically inferred from the reason why wages were fixed by law in the first place. The scheme was to make the taxable property-owners in the city not merely pay the expenses of the legitimate execution of necessary public works, but also contribute to the support of the political "machine." The assessment of the office-holders was "the most convenient way of raising political funds," and, "in order that they might pay these assessments without resistance, the legislature was induced to fix their compensation at a rate higher than the market rate, thus leaving a substantial margin for political contributions. It is easy to see why men who have been engaged in politics in New York should be unwilling to disturb this system or publicly to recognize its existence. But it is not so easy to understand why reformers have not attacked it, or why the public appears to be indifferent to it. But it seems probable that a doctrine known in England as that of the 'living wage' has exerted a silent, but powerful, influence in checking any movement to cut down the wages paid by the city of New York to its servants."

The principle of the so-called "living wage" is then set forth as demanding "that workmen should get more than what their labor will bring in the market." In other words, "they should be paid, not what they will consent to receive, 'pinched by hunger and under the stress of need,' but such wages as will enable them to maintain a proper standard of living. There is a 'moral minimum' of earnings below which they ought not to sink, and employers of labor should observe this principle in dealing with their workmen. But as the ordinary employer is prone 'to do business on business principles,' municipal bodies have been selected by the English Socialists as proper agencies for establishing this 'moral minimum,' and it is said that over two hundred and fifty local governing boards in England—to say nothing of the general government—have now adopted the principle."

The benevolent motive inducing this action in England is not denied; on the contrary, it is positively affirmed. An inquiry as to how far this action has or can secure "an improved standard of living among the poor" is next submitted to reason, and it is shown that whatever increase of wages is thus apparently brought about is the result of subtraction from the wages of those who do not share the favor, as taxation is borne inevitably by the consumer, and the increase of pay to municipal workers is only possible by increase of tax rate. The only possible way to prevent this is by taxing "the luxurious consumption of their employers. If their employers will deny themselves some of their accustomed luxuries, the government can indulge its employees in the luxury of the 'living wage' without calling upon laborers as a class to pay for it." Otherwise the whole class must pay for the privilege granted to the few.

This reasoning seems entirely unanswerable. Without following this able argument in detail to the end, we may say that its author is, in our opinion, able to show clearly that the system is open to serious abuse and public danger; that its effect upon general industry is mischievous; and that safety and economy are to be found only in the application of the same business principles to public business that have been proved by experience to be sound and safe in private affairs.

No Legal Right to Air.

A UNIQUE lawsuit was recently tried in an English court, and, the case having been carried to the court of appeal, the decision of that court has now become a precedent in English law. The issue in the case was the right of enjoining a property owner from erecting buildings on his own land that would interfere with the supply of air to an adjoining building or buildings. The lower court granted a perpetual injunction restraining defendant from so building as to interfere with the supply of air to the adjoining house of the plaintiff. The higher court reversed this decision, so that it now appears that a person might purchase the land surrounding another man's lot, and, so long as he left the latter person access to and from his estate, —a right established by common law,— might build, if he wished to do so, entirely around the inclosed house a building forty stories high, and the owner of the circumscribed dwelling would have no recourse at law, though his holding might thus be rendered practically worthless.

In commenting upon this case, *The Journal of Gas Lighting* (Aug. 23) says no such decision as that which the court of appeals reversed "had ever been given in a court of law in a matter of the kind; and the judge's declaration that the plaintiff had a right to the passage of air coming over the defendant's property was such an important extension of the law relating to light that it is satisfactory to know that the matter was not allowed to rest as he left it." Of course any check upon useless litigation is to be approved, and from this point of view the *Gas Light Journal*, inclined to be liberal in its editorials upon social subjects, approves the action of the higher court. We are not prepared to say that this decision is not good English law; but, if so, it is another instance of the right of the large property holder to disregard the necessities of the small holder. Our contemporary assigns as a further reason for its approval that, if the interpretation of the law by the lower court be sound, enormous difficulties would be put in the way of a freeholder who might have occasion to erect a lofty structure, such as a gas-holder, upon his own land. We quote below the abstract of the decision as given in the article under review. It appears that, while, under English law, the plaintiff had some rights, he had not the right to restrain anybody else from divesting him of those rights,—a state of things that recalls the definition some one gave of Calvinism:

You can and you can't;
You will and you won't;
You'll be damned if you do,
And be damned if you don't.

"It had been argued that the defendant's new buildings interfered with the natural ventilation of the adjoining premises, and this was not denied; but Lord Justice Lopes, for himself and Lord Justice Lindley, laid it down that, while every man has a natural right to enjoy fresh and pure air, so that whoever send noxious vapors or foul air into his neighbor's premises ought to be restrained, the court could not impose upon his neighbor the obligation to keep away noxious smells. It was contended that, irrespective of any nuisance, the plaintiffs had a right to the free passage of air over and above their premises, and to have every disagreeable smell carried away by the current of air that would pass over the premises. It was held, however, that, inasmuch as there was nothing to prevent the defendant from building on his own land, such a right as was sought to be set up could not be supported, and that a man is not bound to see that his neighbor has proper ventilation. Lord Justice Lindley further remarked, in view of the importance of the case, that no one has a right to complain of his neighbor for building on his own land, even though it might diminish the flow of air on the land adjoining, unless there was an immemorial right to the user, or an agreement binding the owner not to build." The *Journal of Gas Lighting* thinks it a matter of congratulation "that what might have proved a source of vexatious lawsuits has happily been removed." . . . "The law of 'ancient lights' is troublesome enough on occasions; but a right to ancient natural ventilation would have lent itself to intolerable abuse."

Liability of Employers for Injuries to Workmen.

In "The Programme of Social Reform" (*Nineteenth Century*, July) Sir John Gorst, M. P., takes a position that appears, rightly or wrongly, to be gaining in popularity. We say rightly or wrongly, because there is another side to the argument than that presented by Mr. Gorst. We shall not attempt the presentation of that other side, our business being for the present with the argument of Mr. Gorst. On the question of employers' liability—one of a number of social questions dealt with by the author—he decidedly takes the ground that employers should be held liable for compensation for injuries received by laborers in service, and he appears to do this with only the one reservation of cases wherein accidents are the results of the workmen's own fault.

After an eloquent portrayal of the condition of the family of a laborer whose main support is rendered by accident no longer a support, but a positive burden, and after a statement that accident insurance only partially meets the real necessities of the case, he asserts that it is desirable that "the burden from which the community at large cannot shake itself free should be fairly and evenly adjusted. In a few cases the loss falls upon the Friendly Society of which the victim is a member; oftener upon the benevolence or sense of justice of the employer in whose service he has suffered; in many cases upon the savings of his family or friends, which the poor apply with such touching generosity to each other's necessities; sometimes upon public or private charity; and, in the last, which is frequently the only, resort, upon the ratepayers, in the shape of the relief of the infirmary and workhouse.

"Justly this inevitable destruction of life and limb in the processes of modern trade and manufacture is part of the costs of rendering the service, or of producing the article, and should be reckoned and paid for as such. It is just as much a matter to be taken into account in determining price as the consumption of material or the destruction of instruments of production.

"The most convenient and effective arrangement for society to make is to cast, in the first instance, the responsibility upon the capitalist of providing the neccessary compensation to the workers and their families, and to leave him to recoup himself by an adjustment, of which the amount would be infinitesimal, of wages, profits, or prices, as the condition of his particular industry may require. The injured worker would thus look to his employer for the indemnity which in a clumsy and unequal fashion society now allots to him; and, if neither wages or profits will bear the minute reduction which the extra cost would entail, some trifling increase of price will have to be paid, as it ought to be, by the consumer for the service rendered or for the article purchased. So far as we can judge from the statistics of foreign countries,—we have no reliable statistics of our own,—about one-fourth only of the accidents which occur in the processes of modern industry are attributable to negligence. A measure like that proposed by the English government 2 years ago, the effect of which was to make the employer liable merely in those cases in which negligence on the part of his servants could be proved, is a wholly inadequate remedy. Everybody who has had any experience of courts knows the difficulty, the expense, and the uncertainty of proving negligence, even where there is not the slightest moral doubt of its existence. But, even if proof were in every case certain, the workers, as to three-fourths of the accidents to which they are exposed, would be no better off than they are now."

The scheme advocated is to have a legalized scale of compensation for various degrees of injury and disablement according to the rate of wages received. This is put forward as being a much more convenient, accurate, and rapid way of arriving at the sums that should be paid for injuries than "the fluctuating caprices of judges and juries." The weak point in the scheme is the fact that it merely shifts the ground of dispute from the question of the amount that should be paid to the question of the degree of injury received. Given a certain degree of injury, a fixed amount shall be awarded; but who shall determine the degree in cases of dispute? Obviously we do not escape the caprices of judges and juries by thus shifting the ground of inquiry. The fact that an English lawmaker advocates this sort of legislation in one of the foremost English magazines does not exempt the scheme from just criticism. Nevertheless, the tendency to emphasize and render more certain employers' liabilities for accidents to workmen is visible in current Socialistic literature, and Mr. Gorst's scheme is one of the signs of this tendency.

Misdirected Effort.

On "Empiricisms in Politics," by Mr. T. Mackay in *The National Review*, is an able argument against misdirected effort on behalf of the working classes. The effort to induce the state to do something which will improve the condition of working people is the misdirection referred to. The abolition of poverty he thinks must be delayed till another step is taken which he calls "dispauperization." He evidently means to imply that pauperism is a deeper depth than poverty. He speaks for himself:

"It would be easy to name other spheres of action where there is need of intelligent, disinterested and unremitting labor. Dispauperization means the restoration of independence, not the abolition of poverty; that is the next step. The whole question of working-class investment is full of problems of the highest importance. Most pressing, perhaps, among these is the organization of a cheap system of credit. In England the useful institution of co-operative banks is in its first infancy. Yet as Mr. Wolff has clearly shown us from the example of other countries, it is an instrument most potent and beneficent in helping to spread the advantages of property over an ever-widening area. Again there is room for endless experiment and for the exercise of the highest constructive ability in devising terms of industrial peace between labor and capital which will satisfy the legitimate claims of both."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Industrial Sociology in the American, English and British Colonial Technical Journals—See Introductory.

*688. The Revolt in Cuba. Its Causes and Effects. Amilio M. Amores (As related to the United States). Eng Mag–Oct. 3000 w.

†761. The Government and the Bond Syndicate. Brayton Ives (An authentic account of the operations of the Government bond syndicate). Rhodes' Jour of Banking–Aug. 5000 w.

†767. New British Markets. I. Western China. Holt S. Hallett. II. Tibet. C. E. D. Black. Nineteenth Cent–Aug. 14000 w.

*772. A New Suggestion in Economics (The abolition of the right of inheritance. A review of Nordau's new book. Conventional lies of civilization). Jour Gas Lgt–Aug. 6. 1200 w.

†784. Boer, Africander, and Briton in the Transvaal. F. J. Ricarde-Seaver (A study of South African peoples, their social organizations, race prejudices, and relations growing out of racial differences). Fortnightly Rev–Aug. Serial. 1st part. 6000 w.

*812. Limited Liability (Editorial. Points out defects in present English limited liability law, and reviews report of a committee of the Board of Trade, which from a practical point of view, contains less guidance than was hoped for). Engng–Aug. 9. 2500 w.

*842. Profit. By a Keen Observer (What is profit? When do we begin to make it?). Irm–Aug. 10. 1100 w.

886. Common Sense on the Silver Question. O. D. Ashley, in the Independent (How the value of the metals has been established; result of the free coinage of silver, etc). Ry Rev–Aug. 17. 4000 w.

904. The Labor Movement (Its rise, progress and achievements). Mach Mold's Jour–Aug. Serial. 1st part. 3700 w.

916. The Relation of Railroads and Their Officials to Employees. Ernest H. Johnson (Practice on the New York, Lake Erie and Western. Selection of employees; training and advancement; supervision and discipline; premiums; insurance, etc). R R Gaz–Aug. 23. 2000 w.

*937. No Legal Right to Air (Unique decision of the English Court of Appeal). Jour Gas Lgt–Aug. 13. 400 w.

*938. The Enforcement of Law. Theodore Roosevelt (A terse, vigorous, and caustic reply to the criticisms which have been made upon the Police Department of New York City, for its honest enforcement of the existing liquor law). Forum–Sept. 4000 w.

*939. Municipal Progress and the Living Wage. D. McG. Means (An able argument against the establishment by law, of rates of wages for municipal work, illustrated by the experience of the Department of Street Cleaning of the City of New York under its present administration. The ground is taken that wages for municipal work ought to compete with wages for other similar work). Forum–Sept. 5300 w.

*940. The Benefits of Hard Times. Edward Atkinson (This article points out distinct benefits which have accrued to the railroad manufacturing and agricultural interests as the result of various periods of panic and business reverses, notably the panic of 1893, and the following period of depression). Forum–Sept. 5400 w.

1046. Manual and Sense Training the Great Problem in Education. Peter T. Austin (A lecture given before the Bridgeport (Conn.) Scientific School. Manual training as an element of success). Sci Am Sup–Aug. 31. 8500 w.

†1061. Trend of National Progress. Robert H. Thurston (A scientific prophecy of the near and remote future of the country). N Amer Rev–Sept. 3800 w.

†1062. Crop Conditions and Prospects. Henry Farquhar (A brief history of the progress of the season with a few of our leading farm products). N Amer Rev–Sept. 3800 w.

†1063. The African Problem. Edward W. Blyden (The author's view of the problem in Africa and America). N Amer Rev–Sept. 5800 w.

†1064. Our Reviving Business. James H. Eckels (Review of lessons learned from recent experience and favorable outlook for the future). N Amer Rev–Sept. 2500 w.

1065.—$1. The Income Tax Decisions as an Object Lesson in Constitutional Construction. Christopher G. Tiedeman. An Am Acad–Sept. 4000 w.

*1066. Evolution of Modern Capitalism. (Review of book by John A. Hobson—"A Study of Machine Production"). Soc Ec–Sept. 2000 w.

*1067. Are Export Bounties Economic? (Editorially answers this question, propounded by a professor in Stamford University, emphatically in the negative, and makes a severe criticism on the so-called "Lubin" plan). Soc Ec–Sept. 1200 w.

*1068. Trusts and Wages. Frederick H. Cooke (The author endeavors to show that the existence of trusts tends to increase wages, as well as to prevent and cure industrial depression). Soc Ec–Sept. 1600 w.

*1069. Outlines of an Effective System of Ship Protection. William W. Bates (A department of commerce; protective measures; discriminating duties; bonding privileges; free and reciprocity goods, etc). Soc Ec–Sept. 3200 w.

*1070. The New English Factory Act (A summary of the chief provisions of this act, which comes into operation Jan. 1, 1896). Soc Ec–Sept. 1500 w.

*1071. National Struggle for Existence. Arthur Burnham Woodford. Soc Ec–Sept. 4000 w.

*1135. Wages and Hours of Labor in Transport Industries (Abstract of the Board of Trade (London) Report). Trans–Aug. 23. 2200 w.

*1165. The Commercial Clauses of the China-Japanese Treaty of April 17, 1895 (Taken from French sources, which have been compared with and revised by the official publications issued by the Japanese Government). Bd of Tr Jour, Eng–Aug. 2700 w.

*1168. Tariff Changes and Customs Regulations (Russia, Belgium & Norway, France, Switzerland, Portugal, Spain, Greece, Java, United States, Costa Rica, Guatemala, Brazil, Peru, Venezuela, Cyprus, British India, British Guiana). Bd of Tr Jour–Aug. 6000 w.

*1169. The Problem of the City. Thomas E. Will (How to abolish or mitigate the poverty of the slums, &c., is the unsolved problem). Am Mag of Civ–Sept. 5000 w.

*1170. A Standard of Value. Ellen Battelle Dietrick (Criticism of views of Arthur Kittson). Am Mag of Civ–Sept. 4000 w.

*1171. The New Factor in the Problem of Government. James A. Collins (The tendency toward combination). Am Mag of Civ–Sept. 3500 w.

*1172. The Abolition of Poverty. Whidden Graham (The author considers the cause of poverty to be lack of work due to the monopoly of land, and suggests remedy). Am Mag of Civ–Sept. 3300 w.

*1173. About Production. E. P. Powell (The consideration of how much gain may be hoped from nationalism in the matter of an equitable distribution of the burdens of society). Am Mag of Civ–Sept. 3500 w.

*1174. The Adopted Home of the Hun: A Social Study in Pennsylvania. William Futhey Gibbons. Am Mag of Civ–Sept. 3600 w.

*1179. From the Great Lakes to the Sea. E. V. Smalley (The purpose of the meeting of the International Deep Waterways Association, with account of the organization; the commerce of the mid-continental waterway; the present situation; discussion of the question of prolonging the waterway of the great lakes to the Atlantic coast). Rev of Rev–Sept. 3000 w.

*1189. Trade Unions (Review of the report of the Chief Labor Correspondent to the Board of Trade). Ir & St Tr Jour–Aug. 24. 700 w.

1214. The Relation of Engineering to Economics. William Kent (Extracts from address before the Mechanical Section of the Am. Asso. for Advancement of Science. Effect of improved machinery and methods). Eng News–Sept. 5. 2800 w.

†1222. A French View of British Industry (Claiming that British industrial success is due to not making mere machines of their students). Ind & East Eng–Aug. 3. 800 w.

*1225. Evolution in Banking (Result of the Conference of Australian Bankers). Aust Min Stand–July 20. 700 w.

MARINE ENGINEERING

Bessemer Steel in Shipbuilding.

THE *Engineering Review* prints an interesting article written by Sir Henry Bessemer which portrays the difficulties that always attend the introduction of a new invention, even the most meritorious. The prejudices of the conservative and the ignorant; the misrepresentations of those whose vested interests are threatened; the fears of the timorous, even after their reason is convinced; wilful misuse by the malicious, who thus seek to prevent or retard the introduction of what they know to be an improvement,—these, together with the normal mechanical, chemical, and physical obstacles that must be met and surmounted, have often discouraged men whose resolution and purpose were strong, but who could not endure the protracted struggle. An abstract of Sir Henry Bessemer's article will show some of the difficulties he had to encounter in getting his steel used for naval construction.

" From the first introduction of my process for the manufacture of steel, I took a deep interest in the application of that material to the construction of ships. My process was published to the world in 1856, and the next few years were necessarily largely occupied with negotiation and development. But so early as 1863 the Sheffield firm with which I was then connected supplied bessemer steel plates for the construction of two stern-wheel barges, the frames having been made of iron. A considerable number of ships were afterwards constructed of bessemer steel, manufactured by Messrs. Henry Bessemer & Co. of Sheffield. They varied from tug-boats of less than 100 tons to a steamer of as much as 1283 tons, the latter having been built as early as the year 1864. In this latter year, indeed, there were no fewer than ten vessels constructed of bessemer steel, aggregating about 7000 tons. The year 1865 also witnessed considerable activity in the same direction.

" Then we come to the first Landore-Siemens steel ship, the twin-screw steamer Storm Cock, 466 tons, built in 1878. Then follow thirteen more bessemer steel ships, the list, however, not showing the tonnage or date. Probably all were prior to 1880, making a total of thirty-four bessemer steel ships built up to that year. I not only took a deep personal interest in this subject, but I invested £10,000 of my own money in order that a shipbuilding firm at that time might develop the use of steel for that purpose. This was in 1864, while the Clytemnestra, of 1251 tons, was being built in Liverpool.

" Although we had constructed no less than eighteen bessemer steel vessels in England previous to the end of the year 1865, it was not until 10 years later that Sir Nathaniel Barnaby, then chief constructor to the admiralty, appeared to wake up to the desirability of employing steel for the construction of ships of war in this country. The fact that the French government was building two large ironclads—the Tempête and the Temeraire—at Brest and L'Ouest seems to have rendered it necessary that the admiralty should offer some explanation as to why they were so much behind the times. Hence, in the paper which Sir N. Barnaby read before the meeting of the Institute of Naval Architects in 1875, he spoke of the devices which the French shipbuilders had adopted for ' coaxing and humoring this material.' He then proceeded to state that ' the points of the greatest interest were those connected with the mode of working the material,' and declared that ' the use of iron hammers in putting it into form was scrupulously avoided.' This makes one wonder whether copper hammers have ever been heard of in connection with the building of iron or steel vessels, and how it was that years before we had managed to construct eighteen vessels of bessemer steel that were deemed suitable for classification at Lloyd's.

"In the same paper Sir Nathaniel declared that the uncertainties and treacheries of bessemer steel in the form of ship and boiler plates are such that it requires all the care that is bestowed upon it at L'Orient to avoid failure. The question we have put to the steel makers is: 'What are the prospects of obtaining a material which we can use without fear and trembling?' And, to illustrate this 'treacherous' material, Sir Nathaniel held up to the meeting a piece of steel plate, about 15 in. by 10 in., bent in the form of a partly-opened book, showing a crack along the central ridge, which did not extend quite through the plate. It required a bold man to show a piece of thin bessemer boiler plate, bent at an angle of about 15°, cracked partly through from end to end, as an example of the steel that they have to treat and tinker up with copper hammers if they ventured to use it."

This illustrates how men of high position will stoop to misrepresentation for selfish ends. Sir Henry Bessemer, commenting upon Sir Nathaniel Barnaby's statement, says: "I do not hesitate to say that, if steel were ever made that would crack with a fair bending at that extremely small angle, such metal could never have been rolled and sheared without the shearings crumbling away in little pieces, and showing to the plate manufacturer that it was little better than cast iron. In all my experience I only know of one way in which a steel plate, no matter what its quality, could possibly be made to crack partly through, and that way is to have it continuously bent backwards and forwards so that the outer surfaces on the bending line would be alternately crushed together and stretched, until the surface metal opens, while the central part is less affected and holds the plate together. If this was done, I need hardly add that the metal was not subjected to a fair test, and ought never to have been exhibited as a failure in bending at a slight angle. That bessemer steel was not what it was represented to be may be evidenced by the fact that at this very time the London and North-western Railway Company had over three hundred locomotive boilers manufactured of that material, with all the specially difficult flanging of the fireboxes accomplished with steel hammers and without a single failure."

Lights on the Ocean.

THE *Marine Engineer* prints a summary of interesting and valuable information relating to color and visibility of lights at sea, published by the American naval hydrographic office as a result of investigations undertaken by the governments of the United States, Germany, and the Netherlands. A marine observatory in Germany in this connection tested some three thousand running lights actually in use on board ship, and found that two-thirds of them failed to meet conditions prescribed by the international maritime conference held in Washington in 1889. It was then stipulated that the word "visible" should mean visible on a dark night with a clear atmosphere. The Germans have further pursued the inquiry by a systematic series of experiments. A light was set up on shore, and observers embarked on board a steamer which ran over a well-buoyed course. The point at which the light ceased to be visible was noted by each observer independently, as well as the point at which it first appeared on the return trip. The mean of the several observations was taken as the limit of visibility of the light under observation. The naval hydrographic office sends out the following:

"The American experiments undertaken at Long Beach light station gave the following results in very clear weather: a light of 1 c. p. was plainly visible at 1 nautical mile, and one of 3 c. p. at 2 miles. A 10-c. p. light was visible with a binocular at 4 miles; one of 29 candles could be seen faintly at 5; and one of 33 candles was seen without difficulty at the same distance. On a second evening, exceptionally clear, a white light of 3.2 c. p. could readily be distinguished at 3, one of 5.6 at 4, and one of 17.2 at 5 miles. The governmental experiments conducted at Amsterdam gave the following results: a light of 1 c. p. was visible at 1 nautical mile, one of 3.5 c. p. at 2, and a light of 16 c. p. at 5 miles distance. The German observations represent more varied conditions, and a larger number of experiments with lights of widely-differing character and intensity.

"In experimenting with colored lights, it is only necessary to use the green, as it has been conclusively proved that, if a light of that color fulfils the required tests, a red one of the same intensity will more than do so. Comparisons of the observed and computed values of the visibilities of green lights disclose the fact that the calculated are smaller than the observed values for short distances, and greater for longer ones; in other words, the green rays are subject to greater absorption by the atmosphere, even when perfectly clear, than rays of white light.

"Hence it is that, instead of being proportional to the square root of candle power, as is the case with white lights, the intensity of green lights is proportional to the cube root of the same, and the factor for multiplying this quantity is, as determined by the German experiments, 0.80 the distance in miles at which a green light or a single candle power is just visible.

"From this rule the candle power required for a green light to be visible at 1, 2, 3, and 4 nautical miles is 2, 15, 21, and 106 respectively. According to experiments at Long Beach cited above, a green light of 3.2 c. p. was fairly visible at 1 mile, and of 28.5 c. p. clearly at 2 miles; these results, however, being from a limited number of experiments. The German trials were much more numerous.

"The extraordinary rapid limitation of the visibility of the green light with the distance, even in good observing weather, and the still more rapid decrease in rainy weather of a character which will but slightly diminish the intensity of a white light, show that it is of the utmost importance to select for the glass a shade of color which will interfere with the intensity of the light as little as possible."

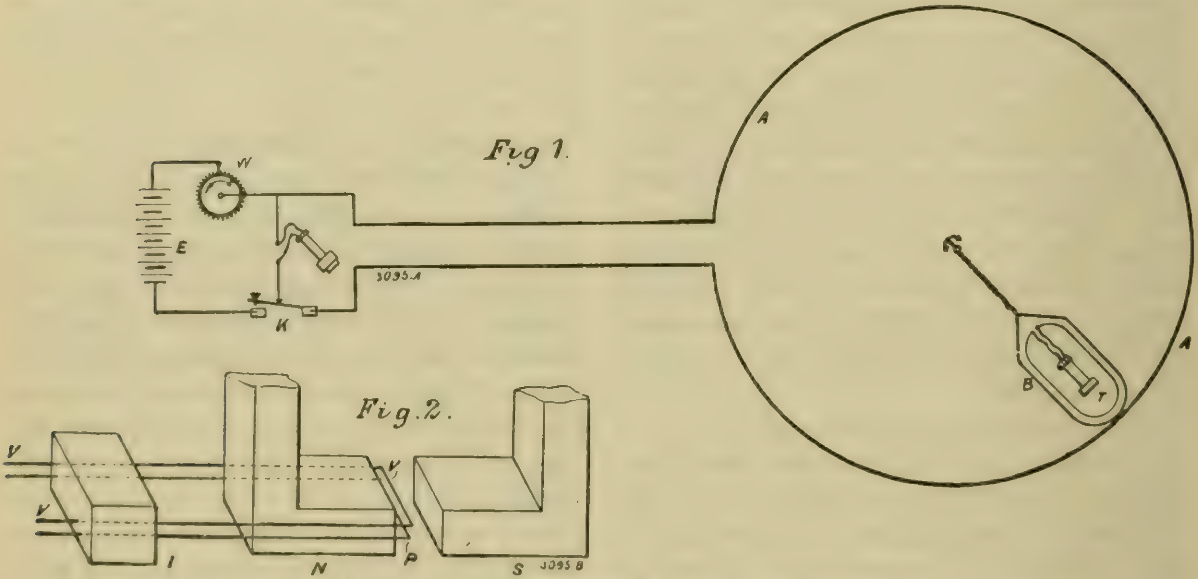
The shade recommended is clear blue-green. Yellow-green and grass-green should not be employed, as they become indistinguishable from white at a very short distance. For the red a considerably wider range is allowable, but a coppery red is probably the best.

With regard to the loss which the light suffers in being transmitted by the glass, tests made show that this varies from 14 per cent. in the case of a perfectly clean glass to 51 per cent. in the case of one in the smoky condition due to a night's burning.

Electric Communication with Lightships.

ENGINEERING (Aug. 9) gives an account of a new apparatus about to be tried for the purpose named in the title. The breaking of cables between moorings and vessels, principally due to chafing, has led to the attempt at effecting communication "wholly by the inductive system, in which the cable lies on the bottom of the sea and the signals are transmitted over the intervening space to the apparatus on board by electro-magnetic induction. Following is a description of the apparatus to be used, which is the invention of Mr. Sydney Evershed of Woodfield Works, Harrow road, London.

"Fig. 1, not drawn to scale, shows a lightship B, able to swing around a mushroom anchor. Around the circle which it is capable of occupying there is laid, on the sea bottom, a ring of cable, A, connected to the shore station, as shown. A secondary coil is fixed on the ship, and should consist of, at least, fifty turns of insulated wire, of as low a resistance as possible. If the ship is built largely of iron, the secondary coil should be arranged around the outside of the bulwarks; its magnetic axis must be, as nearly as possible, normal to the plane of the ship's decks. Of course the coil must be as large as the dimensions of the vessel will permit. Interrupted currents are sent through the submarine cable by means of a key, *K*, and a contact-breaker, W, driven at such a speed as to interrupt the current several thousand times a second. The discontinuous currents in the cable ring, *A*, produce rapidly-alternating electro-motive forces in the secondary coil, and alternate currents pass through the telephone, *T*, and indicate their presence by the buzzing of its diaphragm. The signals are read by the Morse code. The difficulty with inductive telegraphy lies in calling the attention of the operator, as, of course, he cannot live with the telephone at his ear. This difficulty appears to have been removed by Mr. Evershed in an exceedingly ingenious manner by the invention of a cumulative impulse relay. Several forms of the instrument have been worked out, one of them, on the principle of the D'Arsonval galvanometer, being illustrated in Fig. 2. A rectangle of wire, *V*, is clamped in an insulating support, *I*. One side of the rectangle is placed between the poles, *N S*, of a powerful magnet, and, when the rectangle is traversed by alternating currents timed to correspond to its frequency of vibration, it receives a series of cumulative impulses, and is set in vibration. This vibration brings it against a contact on the similar rectangle, *P*, which is tuned in unison with *V*. When the two touch, the circuit of a local battery is closed, and a bell is rung. The two similar rectangles are used to prevent accidental contact due to mechanical jars. The second rectangle may be traversed by alternating currents in the opposite direction to the first. The currents employed in calling are not the same as those for speaking. A frequency of twenty to forty periods per second is suitable, and is obtained by means of a tuning-fork or other similar device. The vessel on which the induction telegraph is to be tried in the first instance is the East Goodwin, which lies outside the Goodwins, and will require a cable some 10 nautical miles in length."



ELECTRIC COMMUNICATION WITH LIGHTSHIPS.

PLANS for two new double-turret battleships for the U. S. Navy are being prepared. A smaller turret will be placed vertically above the large one. In addition to these vessels the Government is about to build three new torpedo boats, somewhat larger than those for which contracts were recently allotted. Their displacement will be about 185 tons and their speed 26 knots an hour. Water tube boilers will be used and the engines will be of 3100 H. P. One of these vessels will be built on the Pacific Coast, one on the Mississippi, and one on the Gulf of Mexico.

THE British warship *Terrible* was launched on the Clyde May 27. She is a first-class steel cruiser, copper sheathed, and of 14,250 tons displacement. Her indicated horse power is 25,000, and her speed is estimated at 22 knots. She is 531 ft. long and 71 ft. beam. She will be armed with two 22 ton, 9.2-in. guns, and 12 6-in. quick firing guns and 37 smaller guns.

In his address before the American Association for the Advancement of Science, Mr. William Kent said that improvements in engineering methods often cause the destruction of vast amounts of fixed capital by the substitution of new appliances for the old. The British Government expended in 1864-70 £28,000,000 on a class of armored gun boats, which before any use was made of them, were condemned as worthless, owing to improvements in the construction of guns.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*687. The Growing interest in Yachting. W. P. Stephens (Importance of the yacht building industry as related to design of vessels, the cultivation of a taste for maritime sports, and diffusion of information relating to marine affairs among the people at large). Eng Mag–Oct. 3500 w.

*705. Lights on the Ocean (Results of special investigations undertaken by the United States, German and Netherlandic government officers, and published by the American hydrographic office). Marine Eng–Aug. 700 w.

*713. M. G. Meter. Ill. Archibald Denny (Describes a new instrument for measuring the metacentric height of ships). Engng, Lond–Aug. 2. 2000 w.

*714. Experiments on the Strength of Cylindrical Shells. J. C. Spence (Records results of an experimental investigation). Engng, Lond–Aug. 2. 3800 w.

*722. The Distance and Time in Which a Ship may be Brought to Rest from Full Speed Ahead. W. D. Weaver (Formulæ for determining. The author has as yet been unable to compare calculated with actual results). Eng, Lond–Aug. 2. 1000 w.

*723. Traction of Boats on Inland Waterways. Ill. George Cowley (A contention that power haulage on canals should follow the two-line principle, with a strong argument sustaining the contention. Describes an electric locomotive for towing boats by tow-line haulage). Eng, Lond–Aug. 2. 1500 w.

*726. The Use of Bessemer Steel in Shipbuilding. Abstract of article by Henry Bessemer, published in the Engineering Review (Progress in construction of steel ships). Ir & Coal Tr Rev–Aug. 2. 900 w.

799. The Accident to the Steamer "La Touraine." Ill. (Plates of the hull sheathing loosened and cracked). Eng News–Aug. 15. 900 w.

800. The American Line Steamer "St. Louis." Ill. (Descriptive with editorial). Eng News–Aug. 15. 7800 w.

*809. New Dock Works at Southampton. Ill. (Descriptive). Engng–Aug. 9. 4000 w.

*810. The Dredger "Percy Sanderson" for the Danube Regularization Works. Ill. (Description of a chain-basket dredger, built and engined under the direction of Sir Charles Hartley, long identified with the improvement on the Danube). Engng–Aug. 9. 1500 w.

*815. Safety Liners for Propeller Shafts. Ill. (Descriptive). Engng–Aug–9. 400 w.

*818. Electric Communication with Lightships. Ill. (Evershed's apparatus. Descriptive). Engng–Aug. 9. 500 w.

827. Increase in Resistance of Vessels Traversing Shallow Water. Ill. I. McKim Chase. Eng–Aug. 17. 1600 w.

828. Sea Trial of the "Columbia," U.S. N. (Editorial which commends the voyage from Southampton to New York as an exceptionally fine performance, and assigns reasons for this opinion). Eng–Aug. 17. 1200 w.

*934. Steam Windlasses and Capstans on the American Steamships "St. Louis" and "St. Paul (Illustrated, detailed description). Engng–Aug. 16. 900 w.

971. The Defence of the America's Cup. Ill. W. J. Henderson (Historical account of yacht racing since 1851). McClure's Mag–Sept. 2800 w.

972. The Cup Challenger "Valkyrie." E.L. Snell (Brief popular description). McClure's Mag–Sept. 700 w.

985. Cost of Running an Atlantic Greyhound (Itemized wages with incidentals). Ry Rev–Aug. 24. 600 w.

*997. Voyage of the "Antarctic" to Victoria Land. Abstract of paper by C. E. Borchgrevink (Account of voyage with scientific observations). Nature–Aug. 15. 2800 w.

1040. The Ninth International Yacht Race. Ill. (Discussion of the merits of Valkyrie III and the American yacht, Defender). Sci Am–Aug. 31. 1300 w.

*1085. Windlass and Cable Gears. Ill. (Plan and elevation of gear as used on H. M. S. "Terrible"). Engng–Aug. 23. 700 w.

*1147. The United States Cruisers "Columbia" and "Minneapolis" (A brief criticism on these war vessels as to their speed and use, accompanied by a photographic reproduction view of each). Am Eng & R R Jour–Sept. 1600 w.

1216. A Boom on the Great Lakes (Effect on the carrying trade). Sea–Sept. 5. 1300 w.

1217. Steel Canal Boats (Editorial discussion of cost, capacity and use). Sea–Sept. 5. 800 w.

†1220. Navy Boilers (Comparison of the Belleville water-tube boiler with other types for marine use). Ind & East Eng–Aug. 3. 2200 w.

*1238. The Coast Defense French Battleship "Bouvines." Ill. (A brief description of vessel with dimensions and armament). Eng, Lond–Aug. 30. 1500 w.

MECHANICAL ENGINEERING

Manufacture of Terminology.

THERE seems to be a tendency, when a new term is wanted for a thing or operation in practical mechanics, to seize upon the name which has been used in the shop where the thing or operation originated, regardless of its mechanical or scientific fitness to express all that it should. In this way many defective and awkward technical terms have come into use. Were the effect merely the creation of difficulty in the practical use of the term in speaking and writing, the practice would be less injurious; but the fact is that terms which are made to mean something that their derivation and previous use unfit them to mean lead to confusion and inaccuracy in thought, which is a serious objection to such use.

An example of such a term is "*producer gas*,"—a term which is now employed to signify gas made in so-called "*gas producers*" for use in gas engines, etc., the intention being to distinguish this kind of gas from ordinary illuminating gas. Now, the term "producer-gas" has in it nothing which, to one not previously instructed in its nature and uses, conveys the slightest notion of what it is, except the idea that it is some sort of gas artificially produced. But this is true of most gases; so, in reading about the increasing use and efficiency of gas-engines which use this gas, the lay reader, after a vain search for light upon the nature of the difference between this gas and illuminating gas, is forced to content himself with half-knowledge. The term "gas producer" is equally open to criticism; it really defines nothing. And it seems that in the art of using gas in heat engines there has been a singular outcrop of such insignificant terminology.

Our bright contemporary, *American Machinist* (Aug. 15), ably criticises one of these terms, "*impulse engine*," and asserts that this term not only fails to express the facts relating to the combustion and expansion of gas in engine cylinders, but that, as used, it conveys to most readers an entirely erroneous idea.

"To invent a new word, or even a new application of a standard word, is to incur a great responsibility in any event, and, in the case of an incorrect application of the word, it may cause serious trouble and misunderstanding. Someone has begun the practice, and now it is quite a common one, of speaking of the gas and oil engines of the day as 'impulse' engines. The idea intended to be conveyed, of course, is that the power developed by the engine and taken from the driving shaft for practical uses is first imparted to the piston suddenly and all at once at the instant that the explosion occurs. The use of the word 'impulse' in this connection, meaning by it a sudden application of force, is incorrect, misleading, and libelous. In speaking of the ignition and rapid combustion of the charge as an explosion, we are probably contributively culpable. The expression suggests not only an unsteadiness of revolution in the engine much greater than actually occurs, but also strains upon bearings, connections, and frame that never are encountered. We mentioned not long ago the desirability of some movement for the steam-engine indicator which would enable it to show us clearly what goes on in the cylinder while the crank is passing the center and the transitions of the steam currents are taking place. We have now in the gas and oil engines another place where such an arrangement is peculiarly desirable. We should be able to trace the ignition of the gas and the rise in pressure during the combustion. We know that it takes time. We know from our present indicator evidence that the increase in pressure is not in the nature of an instantaneous shock or of a blow struck, any more than the admission of steam in the steam cylinder is a sudden blow, because we see that the movement of the pencil of the indicator is not sufficiently rapid, and that it does not acquire momentum enough to carry it beyond, or more than slightly beyond, the actual pressure attained and represented. The indicator tells us even now that these engines, so far from being 'impulse' engines, or being driven by a blow like that of a sledge upon the piston at the beginning of the working stroke, are instead more truly expansive engines than any steam engine that ever existed, and that the driving by expansion continues for the entire stroke, while in the steam cylinder the expansion is only for the portion of the stroke remaining after the cut-off. No steam engine runs by expansion alone, as the gas engine does. There is always a certain portion of the stroke, when the cylinder is filling with steam, and by its pressure driving forward the piston, which certainly does not do that work by the expansion of that charge of steam; and only after the cut-off is the work of expansion done. But the diagram from the gas engine shows us that with it 'cut-off' has occurred before the beginning of the stroke, and the entire force of the driving stroke, from the beginning to the end of it, is due to the continued expansion of the burnt gases contained in the combustion chamber and in the clearance spaces at the beginning of the stroke. Of course, we understand that in these engines every stroke is not a driving stroke, and that in some of them the intervals of intermission vary according to the power or speed requirements, but we must protest that to call the engines 'impulse' engines gives us no hint of this peculiarity, but that it does give us a hint of something that does not exist."

A literary and scientific bureau of experts, to which new technical terms might be referred for approval before their use could be regarded as authorized, would be very useful. The work of such a bureau might profitably be extended to the revision of terms already in use. The number of words now used in the arts as technical terms is great. Different words are used in different English-speaking countries to signify the same thing; and even in the same country in different localities things are called by different names. Many an American reader perusing an English technical paper will find terms entirely unfamiliar to him, which, when he has ascertained their meaning, he discovers to be used to indicate familiar things or processes. Difficulty and confusion are thus created that might be easily avoided by the authoritative action of some competent body in the adoption or exclusion of technical terms.

The Efficiency of Heating Surfaces in Steam Boilers.

ENGINEERING for July 12, in discussing the efficiency of heating surfaces in steam boilers, says that the erroneous statement so often made that heat passes from the furnace gases to the water in a boiler at a rate which varies directly as the difference between the temperatures of the two fluids probably originated in a misapplication of the following sentence, which occurs on page 258 of Rankine's "Steam Engine": "The rate of conduction through a flat layer of uniform thickness is simply proportional, directly to the difference between the temperatures of the two surfaces of the layer, and inversely to its thickness." It points out, however, that Rankine was speaking only of what takes place in the substance of a homogeneous plate, the two surfaces of which are maintained at known temperatures: whereas in boiler work the only temperatures dealt with are those—known or assumed—of the water and gas respectively.

It has been shown by Dr. Kirk that, as the thickness of the plate was reduced, its temperature became more nearly that of the water, the two temperatures becoming equal when the plate is ¼ in. thick.

The principal cause, after soot, of the great difference found in practice between the temperature of the furnace gas and that of the dry side of the plate is probably the fact that, as soon as the layer of gas next the plate has given up part of its heat, it forms a badly-conducting screen, which prevents the rest of the hot gas from touching the plate till it has moved out of the way by connection or otherwise. The varying resistance due to this layer of comparatively cool gas is assigned as a reason, though perhaps not the only one, why the above-quoted sentence of Rankine is not applicable to boiler problems.

In some experiments by Blechynden, he found that the influence of thickness on the rate of heat transmission was small, even with perfectly clean plates, while it was practically *nil* when the plates were at all dirty. From experiments by Stromeyer, *Engineering* concludes that the rate of transmission varies as the *square* of the difference of temperature, or, in other words, that the rate of transmission *per degree of difference* is simply proportional directly to the difference between the temperatures of the water and the furnace gas.

It quotes Mr. Blechynden in support of this statement that the efficiency of heating surfaces varies as the square of the difference of temperatures, and insists upon the importance of making this difference as large as possible by means of rapid combustion, obtained by fan blast or high chimneys. It cites the fact that Mr. Thomas Fletcher of Warrington, in a lecture delivered in 1886, distinctly foreshadowed the Serve tubes, and described the increased efficiency he had found with internally-ribbed flues. This was ascribed to the fact that, as the conducting section of the ribs was small in comparison to their heat-absorbing surface, they soon reached the critical temperature at which flame contact was possible.

Mr. Fletcher exhibited two vessels,—one with a plain bottom, the other with studs projecting from its under surface. Although the surface of the latter in contact with the water was stated to be only half that of the plain vessel, it boiled a gallon of water in little more than half the time required by the plain vessel, so that the studded surface was over three times as efficient as the plain surface.

He also boiled water in a vessel placed over a powerful gas-burner of the Bunsen type, and showed that a piece of paper, which would char if raised to a temperature of 400° F., was not discolored when pasted under the bottom of the vessel used as a boiler. When the eye was placed on a level with the bottom of the vessel, a clear space was seen between it and the flame. The thickness of this space exceeded that of the paper by about $\frac{1}{10}$ in.

Mr. Blechynden used vessels having thick bottoms made of boiler plate, in which he boiled water at atmospheric pressure. Their sides were carefully protected from flame and radiation, so that all the heat reaching the water had to pass through the bottoms of the vessels.

A mass of asbestos lumps, covered by a sheet of wire gauze, was maintained at a steady heat by gas-burners, this being found a more constant and uniform source of heat than a naked flame. The units of heat passing per degree of difference of temperature were calculated from readings of three thermometers,—one in the water, one immediately under the boiler, and the third immediately over the heated wire gauze,—and the result of these experiments was the determination that the efficiency of heating surface varies as the *square* of the difference of temperatures.

Engine Foundations.

In line with what is said above regarding boiler efficiency, an article in *Lord's Power and Machinery Magazine* for July discusses defective and effective engine foundations. It quotes a prominent engine builder as saying that "more than half the trouble with engine alignment after a few years' run, also many other ills which an engine is heir to, might be traced directly to improperly-laid foundations." The article proceeds to give the following specific directions for constructing engine foundations :

"The first thing to take into consideration is the character of the soil. Should it be solid rock, why, then, all that would be necessary would be to drill and place the anchor bolts, but this is very seldom seen. If the soil is very spongy, then piles should be driven, and on top of them iron rails should be laid crosswise for several layers and the squares filled in with Portland cement. This forms what might be called a sub-base, on top of which the regular foundation is to be laid.

"If the soil is sandy, piles are seldom necessary, except in case of quicksand, but, instead, a trench should be dug below the frost line and filled with broken stone puddled with cement. On top of this should be laid the anchor stones, say 6 ft. long by 18 in. wide by 9 in. thick. They should be drilled to have the anchor bolts pass up through them, being held on the bottom by large nuts and wide iron washers. These bolts should be of sufficient length to give proper depth to the foundation, which is governed wholly by the size of the engine. The space between the bottom and the cap, or top foundation stones, should be filled in with broken stone and cement, using plenty of the latter. This makes a solid, immovable foundation for an engine of any size, which can be set directly on top of the trenches; but in many cases owners are compelled to place their engines higher in the air; then brick piers are necessary. In this case the cap stones are carried up to the desired height and the space filled in with brick. A hard-burned brick should be used and put together with a very little carefully-prepared cement. Masons generally use for this work the best quality of Rosedale cement mixed with not more than two parts of sharp sand. The bricks should be wet before being used, and, after setting, should be allowed 2 weeks to become perfectly solid.

" Whenever it is possible, the anchor bolts should run from the bottom up through the engine bed, which is easily arranged, so far as proper placing is concerned, by using a wooden template, furnished with every engine, to guide the foundation builders. This does away with a second set of bolts for the engine; but, when this is not feasible, then the bolts holding the engine frame to the foundation are placed only in the cap stones.

" When the anchor bolts are to be used for both purposes, it is always well to leave a trifle of play-room around them. Say, for instance, for a 1¼-in. bolt a 2 in. hole should be left in the foundation.

"The template has, or should have, a line drawn through it representing the entire line of the engine from cylinder to crank, and in a line at right angles with this to correspond with the line of the engine shaft. With these it is easy to set in the template just as the engine would be set up with the shaft line exactly parallel with the shafting in the building, or where it is to come.

" Where a separate set of bolts is used for the engine, taper bolts are required, which should be noticed. These are placed in holes drilled in the cap stones, which, after the engine is in place, are filled with sulphur.

" When this is all finished, the engines must be put in place of the template. In doing this the bed is put in position, resting upon iron wedges, so placed that any part of the engine frame may be raised or lowered. The engine must then be brought in line or parallel with the shafting, and must also be perfectly level, and levelled and lined within itself; that is, each portion of the engine must be level and in line with each other part, as well as with the shafting. The nuts are then screwed down, but not to their full extent, and the engine is raised or lowered by the wedges, until it is perfectly level; and, when we say level, we mean that 'near enough' will not do, for, in order to run satisfactorily, the machine must be 'plumb level and square.' When the engine is thus leveled and lined, it is ready for its bedding. This bedding is either sulphur or cement put in liquid form between the engine bed and the foundation stone, to set the bed where it now is, the sulphur or cement soon hardening as hard as the rock itself. Some makes of engines have a hollow chamber in the bed plate, which is intended to be filled with cement and gives it the added firmness, as settling it down over the rock would. To properly pour sulphur is something of a task, demanding considerable care, first in pouring, and also watching to see that the sulphur does not get too thick from overheating. The sulphur used is heated or melted in pots, but, if heated too much, it becomes thick and will not fill all the crevices before hardening, making the same difficulty which is often experienced in the foundry when the melted iron is not sharp enough.

" To do the pouring, a runner of clay is built around the engine bed, or, in other words, a little trough all around, about an inch from the edge of the bed. The melted sulphur, when poured into this trough, runs under the frame, filling all the space between the frame and cap stone. It is usually necessary to divide the pouring into sections, not attempting to pour it all at once, as it is apt to cool too quickly if one tries to cover too much surface. Where sulphur is used, the hollow space inside of the engine frame, if there is one, is blocked with hemp or other material to keep the sulphur from running in, as it is never used in quantities like the cement mentioned above. Before the whole is set, screw down gradually on the bolts, a little at a time, until the engine is securely held in position on the foundation, care being taken not to disturb the level of the engine."

Wind as a Motive Power in the United States.

THE popular idea that the use of wind power in the United States is but slowly advancing is shown, in an article by Frank Waldo, Ph. D., in the September number of *The Review of Reviews*, to be an error. On the contrary, progress in the utilization of wind power has been rapid and extensive. "Over one hundred firms" in the country "are engaged in the manufacture of wind wheels," and the author thinks "it would not be excessive to estimate the total number of wheels at present in use at upward of half a million." He also estimates the annual increase at "over fifty thousand. . . . Probably 60 per cent." of the firms engaged in this manufacture are "within 200 miles of Chicago. About eight firms are located east of Ohio. . . . About half a dozen are located on the Pacific coast."

The uses to which power thus obtained is applied are various, but the chief use is the pumping of water, not alone for domestic supply, but for irrigation and other purposes. Farm implements, such as churns, feed-cutters, etc., are frequently driven by wind wheels. The author expresses the belief "that the utilization of wind power by means of wheels as a pumping force will be the main method by which our arid regions in the west will be reclaimed by irrigation." He also looks forward to an extension of the use of wind power in the "accumulation of electrical energy when a convenient storage system shall have been put on the market."

The amount of available wind force and its constancy are discussed from data obtained from records of the United States Signal Service and Weather Bureau, and four charts are given, representing "lines of equal wind velocities" in the United States,—two for January, and two for July. Of the two charts for each of these months, one gives the lines of equal wind velocities, and average velocities in miles per hour, for "well exposed stations," and the other gives the same data for "low exposed stations." The information thus afforded is of value as an addition to engineering data.

The proposition to substitute non-adjustable wind wheels for the self-adjusting ones now in use is also considered, with apparent approval of the system. Instead of presenting the entire face of the wheel to the wind, as do the self-adjusting wheels, the proposed system contemplates the use of "large non-adjustable wind wheels, somewhat after the fashion of the stern wheels on western steamboats, the axis of the wheel being arranged transversely to the prevailing wind direction. Of course the return half of the wheel would have to enter a box, or be so otherwise protected that the wind should not strike it. If such a wheel is made to revolve horizontally around a vertical axis, it could be placed in a fixed position, and the light shelter-box could be made adjustable for any side," or it could be made "automatically adjustable."

Lignum Vitæ Bearings.

IN *American Machinist* (July 18) Mr. J. McKim Chase says that his early experience with lignum vitæ bearings for machinery leads him to wonder why this substance is not more used for bearings, gibs, etc. He advocates its use "whenever opportunity and the conditions of the case are favorable," and gives suggestions for using it to best advantage. He says that for this use "it should always be arranged so as to take the wear on the end of the grain. In this position, when efficiently lubricated and not subjected to excessive pressure, its resistance to wear is somewhat astonishing. When the wear is taken on the side of the wood, or with the grain, it is less durable, and lubrication is more imperative. When run dry on the side of the grain, a much softer material will wear it rapidly, as may have been observed in the case of a boy's wagon having wheels of lignum vitæ and axles of some other wood. As a lubricant for lignum vitæ, water appears to be as efficient as oil, especially when the bearing is on the end of the grain, but the supply of water should not be stinted."

Mr. Chase gives his experience with this material for crosshead gibs on a double marine engine of the inverted vertical type, having very short connecting rods, which caused much trouble with the crosshead gibs. After the return of the vessel to Baltimore from Charlestown the gibs nearly always required renewal or lining out. " After several different materials had been tried with indifferent success, I induced the engineer to substitute lignum vitæ. He expressed great doubt as to its success, chiefly on account of the limited thickness available for the wood. However, I recessed the pattern which had been used for the metal gibs, and managed to get a depth of about ¼-in. thick. The gibs being prepared, I fitted lignum vitæ into the recesses, with the end grain bearing on the guides. No necessity was found for fastening the wood to the gib castings, because, when in their places in the engine, the wall of metal around the recesses prevented the wood from getting out. And I can testify that no further trouble was experienced with those gibs while I remained at the establishment where the vessel was repaired, which was several years after the lignum vitæ had been applied."

Having also tried it in the stern bearings of propeller shafts, fitted with it so that the bearing should be on the end of the grain, and also for the end bearing of a vertical shaft, he found it equally satisfactory. " Feed the lubricant into the center of a bearing of this character."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Technical Journals—See Introductory.

The Machine Shop.

*725. Notes on Modern Steel Works Machinery. James Riley (Notes progress in this class of machinery as tending toward increased strength and power, with reference to important machines in use in many large establishments). Ir & Coal Tr Rev–Aug. 2. 5500 w.

879. Burnt Steel (An application of theory). B. F. Spalding. Age of St–Aug. 17. 1800 w.

897. Making a Miter-Gear Pattern. Ill. P.S. Dingey (A practical discussion of a method of making this class of patterns, wherein the teeth are separately made and fastened on the rim). Am Mach–Aug. 22. 1100 w.

902. The Use of Milling Machines. Henry B. Binsse (Milling machine economy is regarded as a function of the duplication of the product). Am Mach–Aug. 22. 1600 w.

1017. Some Special Tools in the Cincinnati Milling Machine Company's Shops. Ill. John Randol (Describes some very interesting machine tools and fixtures used for special work of difficult form and wherein first class fitting is required). Am Mach–Aug. 29. Serial. 1st part. 2000 w.

1048. The sharpening of Files by Sand Blast. Ill. Mr. Desgeans and Mr. Fort (Description of process). Sci Am Sup–Aug. 31. 1700 w.

1161. Drawings for the Shop. Ill. C. H. Benjamin (A systematic method of making working drawings). Mach–Sept. 2200 w.

1164. Modern Machine Shops. Ill. (Shops of the De La Vergne Refrigerating Co.). Mach–Sept. 2200 w.

1223. Roll Lathes and Roll Turning. Ill. A. Randolph (Description of tools and methods in use at shops of Robinson–Rae Mfg. Co., Pittsburg, Pa). Mach–Sept. 1300 w.

Steam Engineering.

*699. Lancashire Boiler Setting. H. O'Connor (Reasons for methods adopted, rules for calculating area of flues and chimneys, materials used, etc). Ill Car & Build–Aug. 2. 1400 w.

*868. The Measurement of Jacket Water in a Gas Engine. Frederick Grover (Describes a method and apparatus). Prac Eng–Aug. 9. 900 w.

*869. Arndt's Oekonometer. Ill. (Describes this instrument, the purpose of which is to determine the degree of efficiency in the regulation of combustion in boiler furnaces. An index finger indicates the efficiency). Prac Eng–Aug. 9. 1100 w.

*870. The Bulging of Locomotive Firebox

Sheets. Ill. (Report of a committee of the Am. Mas. Mech. Asso. specially appointed to investigate this subject). Prac Eng–Aug. 9. 1400 w.

898. High Speed Without Knock. Charles T. Porter (An argument proving that an engine cannot knock on the centers unless compression exceeds boiler pressure before the induction port is opened for admission of steam). Am. Mach–Aug. 22. 1000 w.

900. Novel French Boiler-Heated Feed Water. W. H. Booth (Describes a new, so-called, self feed water heating boiler of French design). Am Mach–Aug. 22. 1100 w.

1004. Expansion of Steam Pipes (How much it is. The conditions affecting it). Bos. Jour Com–Aug. 24. 1700 w.

1011. National Association of Stationary Engineers—Educational course. Sixth lecture of Prof. R. E. Carpenter (The steam engine indicator ; use ; indicated and dynamometric power ; parts ; reducing motion ; indicator card ; accuracy ; calibration of indicator spring ; test for parallelism of the pencil movement to the axis of the drum ; to adjust and calibrate a drum spring ; method of attaching ; directions for taking diagrams, etc). Safety V–Aug. 15. 4500 w.

1014. On Governing Steam Engines by Throttling and by Variable Expansion. H. Riall Sankey (An argument to show that while the general verdict favorable to variable expansion governing may be accepted, its advantages are overrated, and in some cases *nil).* Safety V –Aug. 15. 3000 w.

1016. Various Kinds of Slide Valves. Charles A. Hague (The gradual decline in the use of slide-valves for automatic stationary engines is noted and its shortcomings discussed, followed by remarks on the design and setting of this class of valves illustrated by diagrams). Am Mach–Aug. 29. 2200 w.

*1075. Steam Engine Economy : Condensing Engines. Henry Davey (Discussion illustrated by diagrams and cards). Ind & Ir–Aug. 23. 3500 w.

1129. Heating Surface of Boilers. C. W. Maccord, Jr. (Discussion of what constitutes the heating surface of a boiler, with tables giving standard dimensions). Power–Sept. 1000 w.

1155. Mechanical and Electrical Regulation of Steam Engines. Ill. (John Richardson in the Pro. of Inst. of Civ. Eng. A valuable article on steam engine governors). Ir Age–Sept. 5. 3300 w.

1231. The Purification of Boiler Feed Waters. Francis Wyatt (A general article on renewal of solid matter in solution in water used for steam). Eng & Min Jour–Sept. 7. 1200 w.

1242. The Effect of Oil in Steam Boilers (Showing the tendency of oil to deposit over particles in the boiler water and deposit along with them, forming a still more dangerous scale). Ry Mas Mech–Sept. 900 w.

Miscellany.

*693. Racial Traits in Machine Designing. Albert Williams, Jr. Eng Mag–Oct. 3500 w.

*700. Smoke Prevention (Account of various patented devices for smoke prevention). From Locomotive Engineer. Ill. Car & Build–Aug. 2. 1700 w.

*702. Recent Progress in Steel Casting. H. L. Gault (Paper read at A. S. M. E). Prac Eng–Aug. 2. 2400 w.

747. Strengthening of Permanent Way (Abstract of paper read by William Hunt at International Railway Congress. Section of rail and calculations of strain imposed by rolling load). Ry Age–Aug. 9. 1600 w.

763. The Honsby-Ackroyd Oil Engine. Ill. (Descriptive). Ry Rev–Aug 10. 2000 w.

791. The Daimler Gas and Petroleum Motor. Ill. (Descriptive). Sci Am Sup–Aug. 17. 1700 w.

794. " Impulse " Engines Without the Impulse. Editorial (A criticism of terminology). Am Mach–Aug. 15. 600 w.

795. The Draw Cut (A study of the action of cutting tools). Am Mach–Aug. 15. 1500 w.

*813. The Strength of Metals at High Temperatures (Reviews modern experiments, and gives a table of tenacities of various metals and alloys at various temperatures). Engng–Aug. 9. 900 w.

*816. Locomotive Piston Rods. H. Rolfe (Discusses the subject of enlarged ends and current notions regarding this feature ; tail-rods ; thrust of piston opening crossheads ; valve-spindle sockets ; turning down rods for wear ; material for rods ; screw ends ; etc). Engng–Aug. 9. 4800 w.

*857. Coal Elevating and Conveying Machinery. Ill. (Coal taken from barges and deposited in any part of the coal store at the rate of 20 tons per hour. Coal raised by steel buckets). Eng, Lond–Aug. 9. 1300 w.

863. The Foundry Yard. A. Sorge, Jr. (Proper and systematic arrangement and care of materials should be one of the principal duties). Ir Tr Rev–Aug. 15. 2200 w.

*864. Notes on Modern Steel-Works Machinery. James Riley (Abstract of paper read before the Inst. of Mech. Eng., Glasgow. Rolling-mill engines ; logging mills ; hydraulic slab shears ; slab-cutting shears ; plate mills ; hydraulic forging-press cylinder ; &c. Discussion). Ind & Ir–Aug. 9. 7800 w.

*865. Some Notes on Circular Saws. Ill. W. Samuel Worssam (Manufacture ; re-hammering ; manipulation). Ind & Ir–Aug. 9. 3500 w.

*877. The Testing of Oil Engines. Professors Hartmann and Schöttler (A trial of agricultural oil engines made by the German Agricultural Society, at Berlin, in June, 1894). Col. Guard–Aug. 9. 2800 w.

899. Gasoline Road Carriages. W. H. Booth (Sets forth the advantages of this class of motors for mechanically propelled vehicles). Am Mach–Aug. 22. 1000 w.

901. Inspection of Material at Rolling-Mills (Editorial. A criticism of methods used by the Carnegie Steel Company). Am Mach–Aug. 22. 1000 w.

903. Hints on Core Rooms. Herbert M. Ramp (A very thorough, practical discussion of core-room practice and appliances). Mach Mold's Jour–Aug. 2500 w.

905. A Foundry on Wheels. Ill. (Describes a portable foundry for joining railway rails with molten iron as used by the Pleasant Valley Railroad Company). Mach Mold's Jour–Aug. 300 w.

907. The Thorne Typesetting Machine. Ill. (Description of operation of type-setting with this machine). Sci Am–Aug. 24. 1700 w.

917. Some Recent Fuel Handling Machinery. Ill. (N. Y. C. & H. R. R. at East Albany; N. Y. L. E. & W. at Buffalo). R. R. Gaz–Aug. 24. 600 w.

*932. Some Peculiarities of Cast Iron (A discussion of Keep's tests. Comparison of these tests with that of bars 2 in. by 1 in. in section—the common English method). Engng–Aug. 16. 2000 w.

951. English Plate Mills (Discussion and comparison with mills in the United States). Am Mfr & Ir. Wld–Aug 23. 1200 w.

*977. The Haythorn Tubulous Boiler. Ill. (Construction and description). Eng, Lond–Aug. 16. 700 w.

1013. Lubricants and Lubrication (Describes chemical and physical qualities and application of lubricants in practice). Safety V–Aug. 15. 1700 w.

1025. Method of Determining Dimensions of Oval Passes. William Hirst. Ir Age–Aug. 29. 600 w.

*1027. Cost of Steam and Water Power in Montana. M. S. Parker (Read before the Montana Society of Civil Engineers. Discussion with tables). Jour Asso Eng Soc–July. 800 w.

1053. The Uses of Stone Implements. Gerard Fowke (A few uses to which stone implements were put). Archaeologist–Sept. 2000 w.

*1079. The Cornwall Works, Soho. Ill. (Visit of Ir. & St. Inst. to the Tangye Works and to the Staffordshire Steel and Ingot Co.'s works, England). Eng, Lond–Aug. 23. 3000 w.

*1083. The Measurement of Jacket Water in a Gas Engine. Frederick Grover (Calculation in detail). Gas Wld–Aug. 24. 1100 w.

1109. The Exhaust Fan or Blower. C. R. Tompkins (Its application to carrying shavings from planing mill machines). Age of St–Aug. 31. 1300 w.

1114. The Western Union Cold Storage Plant. Ill. (Description of a very large plant). Sta Eng–Sept. 1300 w.

1115. The Water Supply. Otto Luhr (Conditions affecting the supply in refrigerating plants). Sta Eng–Sept. 1800 w.

1116. The "Central Valve" Engine. Ill. (Description with section). Sta Eng–Sept. 800 w.

1121. On the Economy and Future of Motors Driven by Explosive Mixtures. Extract from paper by C. Lambette (Comparison of two, ten and fifty H. P. motors each driven by gas, petroleum and steam). Am Gas Lgt Jour–Sept. 2. 1200 w.

1123. The Old and the New. Robert Allison (Read at the Detroit meeting of the A. S. M. E. A reminiscent paper with discussion). Sci Mach–Sept. 1. 2000 w.

1124. The Woburn Boiler Explosion. Ill. (Description). Sci Mach–Sept. 1. 1800 w.

1127. Air Pumps and Water Shocks. A. Bollinckx (Causes leading to water shocks in the cylinder of steam engines and the prevention thereof). Power–Sept. 1100 w.

1128. Testing Room of the Westinghouse Machine Company. Ill. (Brief description of apparatus). Power–Sept. 600 w.

1130. The Influence of the Amount of Air in Combustion on the Economy of a Furnace (Discussion, illustrated by diagrams, especially in relation to boiler furnaces). Power–Sept. 900 w.

1131. Rules and Tables for the Equalization of Power Developed in the Cylinders of Compound Engines (A copyrighted article by the Philadelphia Engineering Works, containing valuable rules for designing and tables of data). Power–Sept. 1800 w.

1132. Mechanical Draft. Henry B. Praither (Paper read before the Eng. Soc. of Western N. Y.) Power–Sept. 1800 w.

*1138. Trials of Oil Engines at Meaux, France (Condensed article giving results of trials of eight engines). Prac Eng–Aug. 23. 1500 w.

*1139. Tests of Engine and Boilers at the Milton Spinning Co., Mossley (Results of systematic tests in detail, illustrated by cards and diagrams). Prac Eng–Aug. 23. 1600 w.

*1140. Faulty Iron Castings. Walter J. May (Removal of impurities by the use of ferro-sodium). Prac Eng–Aug. 23. 800 w.

1153. Bending Large Pipe by Hand. Ill. (Description of method used in a New York City shop). Ir Age–Sept. 5. 350 w.

1154. Foundry Costs. A. Sorge, Jr. (Classification under the heads of labor, material, and other expenses of the cost of operating foundries). Ir Age–Sept. 5. 2000 w.

1163. Something about "Starting Up" New Plants. William O. Webber (Valuable practical details in installing new machinery). Mach–Sept. 1600 w.

*1177. Wind as a Motive Power in the United States. Frank Waldo (The uses to which wind-wheels are put; questions to be determined in the use of power; some desirable matters for future investigation). Rev of Rev–Sept. 2800 w.

*1234. Modern Oil Engines. Ill. (Description of the Hornsby-Ackroyd patent safety engine). Chem Tr Jour–Aug. 31. 1500 w.

1275. The Measurement of Jacket Water in a Gas Engine. Frederick Grover (Assumes that the jacket water must carry away 36% of the heat, and describes a tank arrangement whereby the required jacket water used may be measured). Am Gas Lgt Jour–Sept. 9. 500 w.

MINING & METALLURGY

Illuminants Used in Mines.

SOME of the most disastrous accidents about our coal mines have been caused by the explosion of gases through the careless use of a naked-flame lamp or candle; and, though the introduction of the Davy lamp decreased the number of such catastrophes, accidental explosions are still sufficiently frequent to cause both miner and manufacturer to look for a safe light. Mr. A. H. Stokes, H. M. Inspector of Mines, has touched upon this subject, along with some practical points relating to mine illuminants in general, in a paper read before the Chesterfield and Midland Counties (England) Institution of Engineers, at its meeting of July 13. Thirteen series of experiments were made to compare the standard candle with the various oils used in safety lamps. The *American Manufacturer* refers to these experiments as follows: " With only one gauze and a lamp gauze having one-third of its internal surface enameled white as a reflector, the measure of increased light in a forward direction was found in some cases to be more than double that given by the same oil and wick in the previous experiment. Comparisons of the standard candle with tallow and wax composite candles of various specified sizes showed that miner's candles, as ordinarily used, gave a greater amount of light than the sperm candle, and generally an equal intensity with the safety lamp. An experiment with the recently-introduced Sussman portable electric lamp showed the intensity of light to be practically the same as that of the standard sperm candle.

" Practical suggestions were made as to the several parts of the safety lamp, such as that the wick tube for a flat wick should be corrugated on one side and be only slightly less in width than the wick to be used in it; and an improved form of pricker for snuffing the wick was recommended. The results of the experiments clearly pointed to the conclusion that the value of an oil for illuminating purposes could best be known by actual photometric experiment. Seed oils, where burned alone, had a tendency to form a crust, and required frequent snuffing, but, when mixed with petroleum, they gave good results. The mixture suggested by the royal commission on accidents in mines was believed to be one of the safest and best illuminants that could be used in safety lamps,—*viz.*, a seed or refined colza oil of good quality, mixed with a paraffin oil of a flashing point not lower than 80° F., in the proportion of not more than one part by measure to two parts of the vegetable or mineral oil.

"The object of the addition of the petroleum was two fold: (1) To reduce the viscosity of the seal or colza oil and to increase its capillarity, and (2) to supply a mixture of hydrocarbon oil that would increase the illuminating power of the flame by rendering it white and clearer burning than when pure vegetable oil was solely used. The price of an oil did not appear to be any guide to its value as an illuminant, either in respect to light or lasting properties. Some of the cheap oils compared favorably in such respects, under the same conditions, with higher-priced ones. To obtain good light from a safety lamp, cleanliness and care must be the motto of the light cabin, and their intent and meaning should be strictly enforced."

It were well if those mines using large quantities of supplies would adopt the plan successfully carried out by our larger railroads. Here all purchases of oils, lubricants, paints, etc., are made on specifications, and the material tested as received, thus relieving the supply department of all blame for inefficient work or accidents. The plan works well, and, in the case of illuminating oil for miners' lamps, would save the miner much vexation and the company many a lamp. Mr. Stokes has treated the subject in a thoroughly practical manner.

United States Coal Production.

THE United States Geological Survey has issued a report upon the coal trade of the country prepared by Mr. E. M. Parker, which includes a description of the several localities, along with statistics of production for 1894. He groups the bituminous coal fields into seven divisions, as follows:

(1) The triassic areas of the Richmond Basin, Virginia, with a production in 1894 of 52,079, short tons, while the North Carolina mines produced 16,900 short tons. (2) The Appalachian field, which follows the Appalachian mountain range from Pennsylvania to Alabama, and produced in 1894 76,278,748 short tons. (3) The northern field, in Michigan, occupying 6700 sq. miles in its central portion, with a production of 70,022 short tons. (4) The central field, embracing Indiana, Illinois, and western Kentucky, with a production in 1894 of 22,430,617 short tons. (5) The western field, between the Rocky mountains and the Mississippi river, with a production of 11,503,623 short tons. (6) The Rocky mountain field, embracing the deposits in Colorado, Idaho, Montana, New Mexico, north Dakota, Utah, and Wyoming, with a production in 1894 of 7,175,628 short tons. (7) The Pacific coast field, embraced by California, Oregon, and Washington, with a production in 1894 of 1,221,238 short tons. The anthracite areas are said not to exceed 480 sq. miles in extent, and have produced since 1820 about 1,000,000,000 long tons. The producing areas lie in central and eastern Pennsylvania, though small quantities of inferior anthracite are produced in Rhode Island, Arkansas, and Colorado. The total production of both anthracite and bituminous coal in 1894 was 152,447,791 long tons, equivalent to 170,741,526 short tons, with a value at the mines of $184,141,564. These figures are for the total quantity mined, including all coal raised from the mine, and are the best obtainable.

The Trouble With Our Southern Gold Mines.

THIS is the title of a strictly general talk by Mr. Courtenay De Kalb in the *Manufacturers' Record* (Aug. 16). Considerable interest is manifested in these properties by English and French capitalists at the present time, and southern speculators are holding their properties at exorbitant and ridiculous prices. It were unfortunate in this period of rapidly renewing confidence that European capital should first settle on southern gold properties, for, to quote Mr. De Kalb, "if we should review the history of gold mining in the South, we would find that it consists largely of a chronicle of disasters. We should find that those few mines which have shipped large amounts of bullion have in nearly all cases been financial failures. . . . This can be explained, almost without exception, by the simple phrase 'over-capitalization'; . . . The mine was sold to credulous people at too high a price, and subsequent developments were made on too extravagant a scale." He likewise states that the people are imposed upon by professed mining experts, and that they never develop their deposits sufficiently to enable themselves or the purchaser to estimate its actual value. In speaking of this he says: "The majority of our southern mine-owners dream extravagant dreams over the value of their undeveloped veins. Because they can trace them for long distances upon the surface, and by a few open cuts and shallow pits extract here and there fancy specimens of 'gold quartz,' they are convinced that they own a great mine, and they think that everyone else should be satisfied with such evidence; but, as a matter of fact, it amounts to very little in the eyes of an experienced man. It shows that there is some gold there, but proves nothing as to the amount. And yet upon this feeble showing the highest hopes are founded and enormous prices asked, which serve no other purpose than to erect another barrier against the profitable exploitation of the property." The southern miner is not yet settled into the mathematical business ways of his more experienced neighbor in the north and west. Though some deposits are paying expenses, it is only through economical treatment.

New Method of Hardening Steel.

THE above is the headline of an editorial in *The Railway Review* (Aug. 31). Cementation was practised years ago by the iron masters of Great Britain, but reappeared successively under such names as "case-hardening" and "Harveyizing," and once more as an "invention" in which "the process is based on the fact that gas under great heat deposits carbon in a solid form." This is often true, though it is more often the case that highly-heated carbonic oxid deposits carbon on any surface cooler than itself. Consequently, when gas is admitted between two pieces of steel so arranged that it cannot escape, it deposits its carbon on the surface of the steel in very close contact with the steel itself. In the Harvey process for tempering armor plates a layer of carbon mixed with some animal charcoal is placed between two superimposed plates. In the "improved" process a more intimate contact is claimed and a consequent greater absorption of carbon. This is a proper claim, and a decided improvement over the usual process of applying carbon in the shape of pulverized coal or charcoal directly to the surface, especially where intimate contact is hard to obtain on account of caking or coking of the carbon, leaving vacant spaces. To quote from the report of the American consul in Germany on this process as used at the French works of Schneider & Cie., Creusot, "Schneider's process puts two plates into the furnace, one on top of the other, with a hollow space between them. This space is made gas-tight by means of asbestos packing put on around the edges. The plates are heated red-hot [bright salmon in the case of the Harvey process.—ED.], and a stream of light gas is poured into the space between them. The carbon thrown off by the gas is deposited on the plates, until they are thickly covered. The depth of carbon covering can be regulated by the quantity of gas admitted. In order to secure regular and uniform action during the process, and to prevent the pipes that carry the gas to the hollow space from absorbing any of the carbon, they are insulated in other pipes through which water is constantly circulating. It is believed that this simple and rapid carbonizing process will soon be applicable to other branches of the steel industry." Tempered carbonized steel possesses such a degree of hardness that it can not be dented with a center punch, and is not in the least affected by a file. Therefore it is remarkable that all wearing parts, such as engine guides, journals not subject to shock, and similar parts, are made of soft material easily scored by grit or excessive pressure and requiring repeated renewals.

The World's Gold and Silver Production.

IN arriving at statistics representing the production of the precious metals in any country, there are many difficulties to contend with which do not appear on the surface. Gold may be valued at anywhere from $15 to $20 per ounce, depending upon the quantity of other metals or impurities with which it may be associated. Small producers in remote localities often refuse to give their production, or grossly exaggerate their reports to suit their private ends. It is very difficult to avoid duplication, for, if the ore is smelted in Mexico, refined in the United States, minted in Europe, and converted into tourist curios, which afterward pay duty at San Francisco, it is extremely difficult to tell positively where it did come from, as it will appear on the books of the mining company, the Mexican export reports, twice on the United States import returns and once on the export returns, once on some European mint report, and also on bank exchange accounts. A large quantity of coin disappears annually by being converted into articles useful and ornamental, and it has been impossible to estimate even the approximate amount. Official reports of mining bureaus are seldom accurate, and the mints never receive a very large part of the actual production. Many other causes conspire to make the collection of such statistics very difficult, and the work done by our mint authorities should be appreciated accordingly.

The following table, from *The Bulletin of the American Iron and Steel Association*, gives the most correct figures as yet issued by the mint:

Countries.	Gold.	Silver.
United States......	$39,500,000	$64,000,000
Australasia.... ...	41,760,800	23,367,700
Mexico........ ..	4,500,000	60,817,300
Russia............	24,133,400	356,600
Germany......... .	1,498,900	8,240,100
Austria Hungary....	1,684,800	2,548,400
Sweden	62,500	119,200
Norway......... ..	....	195,500
Italy	117,000	1,200,500
Spain.............	....	2,643,400
Greece............	....	1,472,700
Turkey	8,000	63,000
France............	185,300	4,076,100
Great Britain.......	65,800	329,700
Dominion of Canada.	1,042,100	1,096,000
Argentine Republic..	95,000	1,551,600
Colombia	2,892,800	2,182,400
Bolivia	67,000	28,444,400
Ecuador	68,400	10,000
Chili	464,400	3,685,500
Brazil..............	2,219,500	....
Venezuela....... ..	851,600	....
Guiana (British).....	2,310,100	....
Guiana (Dutch).....	650,800	....
Guiana (French)....	1,329,200	....
Peru	74,400	4,474,800
Uruguay...........	141,600	....
Cent. Am. States...	470,500	2,000,000
Japan	489,800	2,529,700
China	8,556,800	....
Africa.............	40,271,000	....
India (British)	3,986,900	... .
Corea.............	467,200	....
Total, 1894......	$179,965,600	$215,404,600
Total, 1893......	157,297,000	213,547,800

It will be noticed that, though we have passed through a period of industrial stagnation, the total precious metal production is on the increase, and is liable to continue so.

Equipment of Mining and Metallurgical Laboratories.

THERE has been a long struggle in the lines of technical education in the effort to coördinate the teaching of theory with its practical application. The results of these efforts are seen in our manual training schools, electrical testing laboratories, mechanical laboratories, and numerous mining laboratories. In mining and metallurgy the need for practical experiments conducted systematically has long been apparent. The main point of difference in opinion lay in the extent to which such experiments should be carried, and as to whether they should be illustrative or intended to duplicate actual practice with full-size apparatus. Both these practices have their adherents, though the latest orders from such schools indicate that the mean between models and full-size machinery—*i. e.*, the smallest size found to be efficient in practice—seems to be the size adopted. Prof. H. O. Hofman read a paper at the March meeting of the American Institute of Mining Engineers, under the above title. He introduces his remarks as follows: "The mining and metallurgical laboratory, as we understand the term in this country, is a place in which mechanical and chemical working-tests are made on ores, fuels, and furnace materials. It is of quite recent origin. The first laboratory of this kind to be used in connection with teaching was put into operation in 1871 at the Massachusetts Institute of Technology. . . . Private laboratories for making tests upon ores had previously existed here and there, especially on the Pacific coast, for silver and gold ores; but in the educational field the Massachusetts Institute of Technology was the pioneer. To-day there is hardly a school of mines in this country that has not a more or less complete mining and metallurgical laboratory. In European mining schools there is very little laboratory-teaching. Most of them are located in mining districts, where the students can personally see and engage in the practical work of mining, concentrating, and smelting." Speaking of one-sided instruction, the author continues: "The instructor is liable to give most, if not all, of his time to elaborating unnecessary details of the local methods, past as well as present, and to pass over with amazing celerity those branches of the subject not represented in his district. Yet, even as regards local work, upon which he puts such undue stress, he is likely to be too theoretical, because, not being practically engaged in it, or able to apply such tests as are furnished in the laboratory, he necessarily falls into too abstract a way of viewing the whole subject. The result is that his instruction tends to produce theorists who speak with unwarranted assurance concerning the most difficult problems the engineer has to solve, but who, if confronted with a simple, concrete question, are at a loss what to do. That this lack of laboratory-training in German technical schools (which are among the foremost in Europe) is beginning to be realized as a defect was evidenced by the intense interest and careful study bestowed upon the subject by the commissioners who came to the Columbian Exposition 2 years ago. They did not hesitate to praise our system, and to express the hope that it might be adapted to meet their necessities on the other side of the Atlantic." Referring to large plants and mines as an impracticable adjunct to an engineering school, he continues: "The practical study of mining, in this country at least, is carried on to-day in 'summer schools.' The students spend some time in mines, going systematically through the different kinds of work and thus becoming sufficiently familiar with mine-operations to listen understandingly to lectures on the subject. It is the merit of Prof. H. S. Munroe of Columbia College to have given to the summer school of mining such an impetus that to-day there is hardly an American mining school without this auxiliary course." The equipment of the laboratory he introduces thus: "A commercial concentrating works must treat daily a considerable quantity of ore and must work cheaply, which can only be done if the machines are so connected with one another that the ore shall receive a minimum amount of handling after the work is once under way. In the laboratory, on the other hand, the work, being purely experimental, must be carried on step by step, in a deliberate and tentative way; and it is therefore essential that the operator shall be able to inspect the material under treatment before and after every operation. Consequently the machines must be separate, that they may be easily accessible for starting, stopping, accelerating, and retarding, and may be connected at will,—in short, that the work may be modified indefinitely under the immediate eye of the experimenter. A laboratory in which this principle is neglected carries in it the germ of failure." Then follows a detailed description, with observations and drawings, of the plant at the Massachusetts Institute of Technology, and the paper, after giving the price of such a plant and the number of hours devoted to experiments, concludes with the statement that, "while the student does not handle every apparatus, he sees most of them in operation. Every Saturday each student makes, before the assembled class, an oral report of his laboratory work during the past week, and its continuation for the coming one is discussed and laid out."

Consulting Engineers.

THE *Mining Journal and Commercial Gazette*, London (Aug. 24), in bemoaning the lack of appreciation of mining engineers by directors, says: "To us it seems as absurd to try to run a mining business without a technical adviser as it would be to run a ship without a captain. In fine weather and an open sea the captain is to some extent ornamental, but there is no telling when his presence may be of the utmost importance to all concerned. So also with the engineer; it may happen that for weeks together all will go well without him, but then a crisis suddenly arises, and, if he is not on the spot, and well up in his work, a catastrophe will, in all probability, happen, in proportion to which his retaining fee sinks into insignificance." This is a clear statement of the case, and many promising claims have failed because some friend's friend thought a superintendent's berth would fit him, while the "theoretical" engineer of wide knowledge and experience was simply ignored.

Crystallization of Iron.

IT is well known that slow cooling of any highly-heated mass promotes crystallization; the slower the cooling, the larger and more perfect the crystallization. Mr. Thomas Andrews, F. R. S., according to *Invention* (Aug. 17), has applied this principle in obtaining material for his miscroscopical examinations of the structure of wrought iron, using powers from three hundred to two thousand diameters, and ascertained the following peculiarities: "Large masses of iron, several tons in weight of practically pure wrought iron, were allowed to cool slowly from a white heat. In the process of cooling, the crystallization of the metallic iron occurred. The usual crystals of iron—those which have heretofore been regarded as constituting the ultimate structure of the metal—were found to enclose a sub-crystalline formation consisting of exceedingly small crystals of pure iron, with all the characteristics of the regular order of crystallization. Sometimes these secondary crystals took the hexagonal or six-sided form, the developed angle being about 120 deg., while sometimes they assumed the form of several cubes [probably rhombohedrons.—ED.] The secondary crystals were contained within the area of the larger primary crystals. The markings of the intercrystalline spaces, or junctions of the secondary crystals, were, however, clearly defined, although exceedingly minute. The dimensions of the primary crystals would average about 0.01, the dimensions of the secondary crystals averaging about 0.001. Estimating from the indications of the average microscopical measurement, there must be about one billion of the secondary crystals to the cubic inch of metallic iron. . . . . The mass of metallic iron, on cooling, having reached the crystallizing point, about 740 deg. C., the skeletons of the larger or primary crystals were then formed; as the period of cooling, however, was very slow, the semi-fluid or viscous metal in the interior of these primary crystals seemed, as the process of crystallization progressed, to break up and become divided into a large number of smaller crystals enclosed in the mass of the larger or primary crystals, which had first begun to form. In the course of further experiments on the cooling of large masses of wrought iron, Mr. Andrews also found, by the use of powerful objectives, that these secondary crystals sometimes enclose still more minute forms of crystals of pure iron in the shape of cubes. These may be regarded as constituting a third system of crystallization in pure metallic iron. The experiments further indicate that large masses of heated wrought iron, on cooling from above the temperature of the crystallization of wrought iron,—namely, 740 deg. C.,—are capable of crystallization in three distinct modifications, which may be tentatively called the primary, secondary, and tertiary systems of crystallization in iron, these various modifications being all connected with a regular system of crystallization. . . . . The examinations were made on carefully prepared and polished samples etched with nitric acid and by the use of high microscopic powers. In each case the etching was prolonged under constant observation with lenses, giving time enough to develop the accurate structure of the metal. We have no doubt but that the same or similar modifications of metallic crystallization will be observed in any metal which is slowly cooled, the large crystals forming the skeleton which encloses one or more systems of smaller crystallizations." These observations were made on forgings of practically pure iron about 10 ft. long and 12 in. square, cooling from a white heat.

A Belgian Briquette Plant.

OWING to the interest now shown in the utilization of coal waste, an article contributed to the *Colliery Guardian* (Aug. 9) will be of great interest, showing as it does the arrangement in plan and elevation of a Belgian plant now in operation, and illustrating at the same time the ovoid *boulet* press and the briquette press. The unscreened coal is passed over a cylindrical screen, which separates it into three sizes,—2.75 in., 1.5 in., and 1 in. in diameter. The smaller size is delivered by a bucket chain elevator to a shaking screen, which separates it into three sizes,—0.5 in. and 0.25 in. diameter, and dust, the two former going to a washing apparatus and the dust to a storage bin. After draining, the coal is delivered into a large hopper, sometimes with the coal dust from the bin, as required, and thence drawn into a measuring apparatus where from 5 to 10 per cent. of pitch is added and the whole taken by a conveyor to a Carr disintegrator, thence to a pug mill mixer, where the pitch is softened by steam, and then discharged into two distributors,—one to the *boulet* press, the other to the briquette press.

The presses used are described in the article. It is contended that the *ovoid* form of patent fuel, which requires but little care in manufacture, is preferable to the briquette for domestic purposes, while it may be simply tipped into the holds of vessels without suffering deterioration. There is no reason why such artificial fuels should not replace our expensive cannel coals, especially as their rapid or slow burning can be regulated in the mixture.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Technical Journals—See Introductory.

Metallurgy.

*717. Metallic Alloys (Copper-tin; copper zinc; aluminum copper; chrome-zinc). Col Guard–Aug. 2. 600 w.

*718. Iron-Puddling in Upper Silesia, with Description of a New Gas-Fired Furnace. Ill. Abstract paper by Alexander Gouvy. Col Guard–Aug. 2. 1200 w.

*742. Losses of Gold in Victorian Gold Mining (Editorial. Percentage statistics). Min Jour–Aug. 3. 1500 w.

745. Separation and Treatment of Lead Matte at the Blast Furnace. L. S. Austin (Different taps and modes of separation). Eng & Min Jour–Aug. 10. 2200 w.

746. The Anaconda Hot Air Reverberatory Furnaces. Ill. (With sections). Eng & Min Jour–Aug. 10. 250 w.

757. The South Wales Tin Plate Manufacture (Consular report). Am Mfr & Ir Wld–Aug. 9. 600 w.

759. Blast Furnaces, Aug. 1, 1895 (Statistics). Am Mfr & Ir Wld–Aug. 9. 500 w.

†775. The Physics of Cast Iron (Communications in discussion of the paper of William R. Webster). Tr Am Inst Min Eng–Aug. 10000 w.

†777. The Determination of Graphite in Pig Iron. P. W. Shimer (The purpose of this note is to call attention to a source of error in the determination of graphitic carbon, made by the usual method of solution in hydrochloric acid). Tr Am Inst Min Eng–Aug. 1000 w.

†778. The Effect of Washing with Water Upon the Silver Chloride in Roasted Ore. Willard S. Morse (A record of the conclusions arrived at in explanation of why the amount of silver chloride in actual practice in the mill, does not agree with the amount shown by laboratory-teachings to be present in the roasted ore). Tr Am Inst Min Eng–Aug. 2000 w.

†780. A Comparison of Recent Phosphorus-Determinations in Steel. George E. Thackeray (Difficulties encountered in determining the phosphorus content of material in a manner satisfactory to both seller and buyer). Tr Am Inst Min Eng–Aug. 8800 w.

783. Malleable Cast Iron Ill. (Its manufacture and its properties. A paper read before the Am. Soc. Civ. Eng). Ir Age–Aug. 15. 4200 w.

*829. Recent American Methods and Appliances Employed in the Metallurgy of Copper, Lead, Gold and Silver. James Douglas. Jour Soc of Arts–Aug. 9. 700 w.

853. Notes on Magnetite. William B. Phillips (What magnetite really is; how it may be produced; influence exerted. Results of some experiments). Eng & Min Jour–Aug. 17. Serial. 1st part. 1000 w.

*935. Mossend and Summerlee Iron and Steel Works (Descriptive of a fully up to date, large and important English plant). Engng–Aug. 16. 3300 w.

943. Chemistry in a Car-Wheel Foundry. Asa W. Whitney (From the discussion of the paper of William R. Webster, on "The Physics of Cast Iron." Experiments with mixtures with results). Ir Tr Rev–Aug. 22. 3000 w.

988. The Hardening of Steel. Henry M. Howe (Explanation of the carbon theory and the allotropic theory, with reasons and discussion of the principles). Eng & Min Jour–Aug. 24. 2800 w.

*996. Micrographic Analysis. W. C. Roberts-Austin (Microscopic analysis of steel and other metals, and the methods). Nature–Aug. 15. 2200 w.

1024. Determination of Carbon in Iron—Peiper's Graphical Method (Description with precautions. Consists in rubbing solid sample on porcelain, removing the iron with cupric-ammonium chloride and comparing the carbon with those made by styles of known composition). Ir. Age–Aug. 29. 1300 w.

*1041. Crystallization of Iron. Facts observed by Thomas Andrews (Iron crystallizing at 740 deg. C. contains small hexagonal crystals within the large crystals, and these contain still other smaller ones). Inv–Aug. 17. 700 w.

1090. The Treatment of Zinc-Lead Sulphides. Ill. F. Hille (A short description of a concentrating plant near Freiberg, Saxony). Eng & Min Jour–Aug 31. 1000 w.

*1095. The Thermo Chemistry of the Bessemer Process. Abstract of Prof. Hartley's paper (A thoroughly scientific article with references). Ir & Coal Tr Rev–Aug. 23. 7000 w.

*1096. The Hardening of Steel. Abstract of paper by Henry Marion Howe (Discussion of the various effects accompanying heating and quenching; tables. Read before Ir. & St. Inst). Ir & Coal Tr Rev–Aug. 23. 2600 w.

*1097. The Production of Iron by a New Process. R. A. Hadfield (Effect of aluminum as a reducer of iron oxide). Ir & Coal Tr Rev–Aug. 23. 4200 w.

*1098. A New Method for the Analysis of Chrome Ore and Ferro-Chromium. E. H. Saniter (Description of method). Ir & Coal Tr Rev–Aug. 23. 1500 w.

*1099. On Tests of the Physical Properties of Cast Iron. Thos. D. West (Conditions favorable to accuracy). Ir & Coal Tr Rev–Aug. 23. 3000 w.

*1100. The Direct Puddling of Iron in Belgium. Emile Bonehill (Description of process with discussion). Min Jour–Aug. 24. 2700 w.

1101. Malleable Cast Iron.—Its Manufacture and Its Properties. H. R. Stanford (Read before the Am. Soc. of Civ. Eng. Containing illustrations of melting and annealing furnaces and practical details). Ry Rev–Aug. 31. 4500 w.

*1191. On the Direct Puddling of Iron. Ill. Emile Bonehill (Paper read before the Iron and Steel Inst. Illustrated by three views of the furnace used). Ir & St Tr Jour–Aug. 24. 1800 w.

*1199. The Ironworks of the South of Russia. George Kamensky (Valuable information with statistics of this little known country). Iron–Aug. 24. 5000 w.

*1200. Nickel Steel and Its Advantages over Ordinary Steel. Henry Wiggin (A short paper with an interesting discussion by Mr. James Riley and others). Irm–Aug. 24. 11000 w.

*1201. Small Cast Steel Ingots. R. Smith-Casson (Illustrated description of method of filling the multiple molds from below). Irm–Aug. 24. 3300 w.

*1202. Cooling Curves and Tests for Cast Iron. W. J. Keep (A valuable illustrated paper by an authority on the subject). Iron–Aug. 24. 4400 w.

*1226. Dry Crushing and Cyanide. W. Franklin White, in So. African Jour. (Results of experiments on dry crushed pyritic ore. Abstract). Aust Min Stand–July 20. 2200 w.

*1228. Cyanide Practice. Alfred James (A paper read before the Inst. of Min. & Met. dealing with samples, plant and extraction. Description of process). Aust Min Stand–July 27. 1500 w.

*1263. The Manufacture of Tin Plates in Germany (From U. S. Consular Report on the practice at Chemnitz, Cologne, Dusseldorf and Frankfort, with description in detail of process employed). Ir & Coal Tr Rev–Aug. 30. 5400 w.

Mining.

23. Anaconda Copper Mining Company (Brief history; description of property; company reorganization). Ill. West Min Wld–July 6. 500 w.

24. New Mining Laws (Digest new Montana code). West Min Wld–July 6. 1100 w.

28. Appreciation of Copper Stocks (Editorial. Prices in 1894 and 95 compared). Eng & Min Jour–July 6. 1200 w.

*689. Electricity in Bituminous Coal Mining. R. M. Haseltine (Valuable tests of electric mining machines). Eng May-Oct. 4000 w.

*711. The Phosphate Deposits of Florida (District; mining costs; prices phosphate). Ill. Engng, Lond–Aug. 2. 3000 w.

*715. The Right of Surface Support in Connection with Mining (English legal rulings: comments). Col Guard–Aug. 2. 3500 w.

*716. Distribution of Power in Collieries. Llewelyn B. Atkinson (Abstract of paper read at the So. Wales Inst. of Eng). Col Guard–Aug. 2. 3000 w.

*727. The Emery Deposits of Naxos (Report of British Consul; occurrence; quarrying methods). Ir & Coal Tr Rev–Aug. 2. 2200 w.

*738. Colorado Marble. Ill. Arthur Lakes (Geological; utilization). Stone–Aug. 2000 w.

*741. Notes from Andalucia. William Guthrie Bowie (Copper pyrites deposits). Min Jour–Aug. 3. Serial. 1st part. 6000 w.

743. Calumet and Hecla Mining Company, Michigan (With editorial comments). Eng & Min Jour–Aug. 10. 1200 w.

758. Illuminants Used in Mines (Report of paper by A. H. Stokes; kerosene tests). Am Mfr & Ir Wld–Aug. 9. 900 w.

797. Gold-Mining in Alabama. H. S. Fleming (Prospects for fairly profitable operations). Mfrs Rec–Aug. 16. 1900 w.

798. The Trouble with Our Southern Gold Mines. Courtenay De Kalb (A chronicle of disasters and their causes; how to dispel the prejudices of the past). Mfrs Rec–Aug. 16. 2000 w.

*851. Mineral Statistics of New South Wales—The Gold Output (Editorial on report of the Department of Mines and Agriculture of New South Wales for 1894). Min Jour–Aug. 10. 1800 w.

852. The Coal and Other Mines of Ohio in 1894 (Abstract of report of R. M. Haselton, Chief Inspector of Mines of the State of Ohio). Eng & Min Jour–Aug. 17. 1300 w.

*866. The Dargo High Plains Gold Field (Vic.) (Interesting story of Alpine prospecting). Aust Min Stand–July 13. Serial. 1st part. 2200 w.

*875. The Hirschberg Lignite Deposits in Hesse, with Particulars of the Marie Mine. A. Vthemann, with additional particulars by Dr. Mohs. Ill. Col Guard–Aug. 9. 3700 w.

*923. Electricity in Mining Work. T. B. A. Clarke (An examination of the general conditions which limit the use of electricity in mines). Elec Eng, Lond–Aug. 16. Serial. 1st part. 1700 w.

*928. Diminished Use of Explosives in Belgian Collieries. Victor Watteyne (From a report dated July 9, 1895). Col Guard–Aug. 16. 2200 w.

953. The Manitoba Coal Fields (Localities, history, prices and production since in 1887). Am Mfr & Ir Wld–Aug. 23. 700 w.

980. Compressed Air Locomotives. Ill. (Discussion and description. Advantages for mining purposes). Age of St–Aug. 24. 500 w.

989. The Essen Coal Company's Electric Mining Plant. Ill. Timothy W. Sprague (Descriptive). Eng & Min Jour–Aug. 24. 1700 w.

1005. The Silverton Electric Plant (Description of a three-phase system electric plant, with its advantages over steam power formerly used. Designed to furnish power for the Silverton, Col., group of mines). Min Ind & Rev–Aug. 22. 1000 w.

1008. The New Aspen Plan (A co-operative leasing system of working silver mines, based on richness of ore). W Min Wld–Aug. 24. 800 w.

*1042. Coal Mining in Servia (Brief description of some of the working collieries with their production in 1894). Ir & St Tr Jour–Aug. 17. 1300 w.

1091. The Silver District of Tehuilotepec, State of Guerrero, Mexico. Edward Halse (Descriptive). Eng & Min Jour–Aug. 31. 3000 w.

1092. Sampling Gold Quartz (Information for prospectors. Pocket balance with table of values and fineness). Min & Sci Press–Aug. 24. 900 w.

*1117. Roth's Method of Firing Mine Shots. Ill. Richard Cremer (Exploding a charge by means of chemical action in preference to a fuse). Col Guard–Aug. 23. 2300 w.

*1118. Water Power Applied by Electricity to Coal Dredging. Robert Hay (Owing to expensive fuel, an electric plant run by a Pelton wheel was installed to furnish power for the dredge). Col Guard–Aug. 23. 1700 w.

*1120. The Magnesite Ore Deposits of Greece (Description with analysis). Col Guard–Aug. 23. 600 w.

1158. The Great Gunnison Gold Belt. Ill. Dean Burgess (Observations on various mining camps and claims in the district, with map and view of the city of Gunnison). Min Ind & Rev–Aug. 29. 2600 w.

*1227. The Broken-Hill Proprietary Mine (Review of the official report). Aust Min Stand–July 27. 1200 w.

*1229. Tin Mining in the Malay Peninsula. Interview with W. Straughan (Description of the general conditions existing at the tin mines). Aust Min Stand–July 27. 1000 w.

*1230. Australian Broken Hill Consols Mine (Description of interesting prospecting work). Aust Min Stand–Aug. 3. 900 w.

1233. The Deadwood Placer Claims, Idaho. Ill. Walter Hovey Hill (Brief description). Eng & Min Jour–Sept. 7. 600 w.

*1239 Loss of Head in Air Currents Traversing Underground Workings. Ill. M. D. Murgue (Abstract of paper read before the Chicago Eng. Congress. Experiments showing the advisability of regulating the character of air passages as to friction and contracted areas in preference to increasing blowing capacity). Eng, Lond–Aug. 30. 1000 w.

*1251. Transmission of Power by Electricity (Discussion following the reading of papers.—"Electrical Haulage at Earnock Colliery," by Robert Robertson, and "Water-power Applied by Electricity to Gold Dredging," by Robert Hay). Col Guard–Aug. 30. 7500 w.

*1252. Prospecting for Placer Gold—A Novel and Gigantic Scheme in Clear Creek Canyon, Col. Ill. (A scheme to work the placer deposits in the creek bottom by means of converging the stream on certain points and collecting the gold sand in the usual manner). Col Eng–Sept. 2000 w.

*1253. Coal-Washing. Ill. J. J. Ormsbee, in Trans. Am. Inst. of Min. Eng. (Description of a 400-ton Robinson washer, having an upward current sufficient to carry the coal over and let the heavy matter sink to the bottom of the funnel. The cost and efficiency is fully discussed). Col Eng–Sept. 3800 w.

*1254. Mine Haulage. Ill. (Description of a 18,500 lb. compressed air mine locomotive, working under 600 lb. pressure, with 7×14 cylinders and 36 in. gauge. In use at Glen Lyon, Luzerne Co., Pa., Coal Mine). Col Guard–Sept. 800 w.

*1255. A "Prison" Mine (A sketch of prison life at an Alabama mine, worked by convicts. The sanitary conditions are good, a hospital being included. Up to 4 tons coal required per day per man; all over the required quantity is paid for at the usual rate. Prisoners are not isolated). Col Guard–Sept. 1600 w.

*1259. Cinnabar in Texas. William P. Blake (A paper contributed to the Am. Inst. of Min. Eng. Description of outcrop. Conditions for working are difficult and very little work has been done). Min Jour–Aug. 31. 3000 w.

*1260. Wet vs. Dry Crushing of Gold Ores (Short abstract of principles involved). Min Jour–Aug. 31. 2200 w.

1265. Improvements in Water Spraying Apparatus for Damping Dust in Mines (Experiments with eleven burners and sprays with a description of system employed at the Great Western Collieries, England, with discussion). Can Min Rev–Aug. 2000 w.

1267. Mining Explosives. Vivian B. Lewes (Discussion of three classes of explosives. Class I. Gunpowder. II. The nitroglycerines. III. Westphalite, carbonite, etc., relative to safety, health of miners, etc). Can Min Rev–Aug. 3200 w.

Miscellany.

*739. Measurement of Stone. F. C. Neeb (Differences between quarry and contractor). Stone–Aug. 900 w.

*740. The Alabaster Industry (From report of Vice-Consul Carmichael on Volterra quarries). Stone–Aug. 2900 w.

†774. The Equipment of Mining and Metallurgical Laboratories. Ill. H. O. Hofman (Account of the origin of such laboratories; equipment; cost). Tr Am Inst Min Eng–Aug. 11500 w.

†776. Onyx Marbles. Courtenay DeKalb (Notes, partly the result of individual investigation, partly of information from engineers and others, and partly of research in literature). Tr Am Inst Min Eng–Aug. 4500 w.

†779. The Form of Fissure-Walls, as Affected by Sub-Fissuring, and by the Flow of Rocks. William Glenn (A geological study). Tr Am Inst Min Eng–Aug. 5800 w.

†781. Folds and Faults in Pennsylvania Anthracite Beds. Ill. Benjamin Smith Lyman (Geological). Tr Am Inst Min Eng–Aug. 3000 w.

854. Quarrying. Ill. C. Le Neve Foster (Abstract of lecture,—practical in character,—delivered before the Sanitary Inst., London, Eng). Eng & Min Jour–Aug. 17. 2400 w.

855. Cement Materials in Iowa. E. H. Lonsdale (Abstract of paper read before the Iowa Academy of Sciences). Eng & Min Jour–Aug. 17. 700 w.

*876. A Belgian Briquette Plant. Ill. (Plan and sectional elevation, with the details of briquette and boulet presses, illustrating the screening, washing and patent fuel plant made by the Société Anonyme des Forges, near Charleroi). Col Guard–Aug. 9. 800 w.

880. The Phosphate Industry. Ill. (Statistics). Tradesman–Aug. 15. 700 w.

881. Bauxites of Georgia and Alabama. William M. Brewer (Metallurgy and uses of aluminum. Extent of deposits and use of Bauxite ore). Tradesman–Aug. 15. 4000 w.

*926. Water Power Applied by Electricity to Gold Dredging. Robert Hay (The plant described is the first of its kind constructed in New Zealand). Ind & Ir–Aug. 16. 1800 w.

*929. The Employment of Horses in Collieries. M. Boissier (Abstract of paper read at meeting of the Société de l'Industrie Minérale of France). Col Guard–Aug. 16. 900 w.

*930. New Scheme for Unwatering the Staffordshire Coalfield (An important work demonstrating the manner in which science can cope with coal-mining difficulties). Col Guard–Aug. 16. 1200 w.

950. California's Iron Ore Deposits (Localities and analysis). Am Mfr & Ir Wld–Aug. 23. 1200 w.

954. Iron Ore in Pennsylvania, New York and New Jersey (Production of various varieties). Am Mfr & Ir Wld–Aug. 23. 800 w.

955. Coke Production in 1894 (Editorial, containing production statistics by states) Am Mfr & Ir Wld–Aug. 23. 300 w.

*957. Mineral Statistics of New South Wales (Editorial. Production statistics). Min Jour–Aug. 17. 1800 w.

1006. Coal Production in 1894 (Abstract of report of the U. S. Geol. Surv. by E. M. Parker. Description of coal fields with their production). Min Ind & Rev–Aug. 22. 1600 w.

1007. Suggestions as to Building a Mill (Practical hints and precautions drawn from experience). West Min Wld–Aug. 24. 800 w.

1023. Annealing Armor Plates by Electricity. Ill. W. W. Hanscom, in the Pacific Electrician (The Harveyized face of these plates, being too hard to be drilled, were annealed by heating locally with a maximum current of 6000 amperes at four volts. Description). Ir Age–Aug. 29. 800 w.

†1031. Stratigraphy of the Kansas Coal Measures. Charles Rollin Keyes. Am Jour of Sci–Sept. 1900 w.

†1032. Native Sulphur in Michigan. W. H. Sherzer (Description of deposits). Am Jour of Sci–Sept. 1100 w.

*1076. Prevention of Accidents in Mines. Austin Kirkup (Abstract of paper read before the Federated Institute of Mining Engineers on accidents due to explosives and roof-falls). Ind & Ir–Aug. 23. 6800 w.

1093. Oregon's Gold Beaches. From report of H. V. Winchell and F. F. Sharpless (Character of the deposits). Min & Sci Pr–Aug. 24. 1200 w.

*1119. The Mineral Resources of South Staffordshire. Herbert W. Hughes (Read before Ir. & St. Inst. Occurrence of various substances with their present development and the output of coal and iron stone). Col Guard–Aug. 23. 5000 w.

1122. The Coal Fields of Manitoba (Brief description, with prices and production since 1887). Am Gas Lgt Jour–Sept. 2. 600 w.

†1142. Asphalts and Bitumens. Samuel P. Sadtler (A general lecture giving localities, analyses and uses). Jour Fr Inst–Sept. 4200 w.

1157. The Granite City Basic Steel Works. Ill. (Description and plan of works). Ir Age–Sept. 5. 1500 w.

1232. The Elective System as Adopted in the Michigan Mining School. M. E. Wadsworth (Advantages as compared with fixed courses). Eng & Min Jour–Sept. 7. 1600 w.

1240. Mineral Products of the United States (The quantity and value of fifty-four mineral and metallic substances produced in the United States, since 1889, yearly. The total value for 1894 was $527,655,562. The value in 1893 being $574,201,807). Mfrs' Rec–Sept. 6. Table.

*1249. The Geological Survey of England and Wales (A report by Archibald Geikie on progress of the survey. Four out of the thirteen sheets of the map of England and Wales is published. The South Wales and North Staffordshire coal areas have received considerable attention). Col Guard–Aug. 30. 6500 w.

*1250. Pumice Stone Mining (The analysis of pumice gives silica 73.7 per cent. and alumina 12.27 per cent. Abstract of report on the pumice stone industries of the Lipari islands. It is found in caves and by tunnelling, requiring a total of about 1000 hands). Col Guard–Aug. 30. 900 w.

*1264. The Production and Consumption of Iron Ores (Comparison of the production and character of ores in Great Britain, United States, Germany, France, Belgium, Sweden, Italy, and Austria). Ir & Coal Tr Rev–Aug. 30. 1300 w.

1266. Rock Drills (A discussion of the relative merits of ×, +, and Z bits, with many practical suggestions on the operation of the drills. From the catalogue of the Ingersoll–Sergeant Rock Drill Co). Can Min Rev–Aug. 3500 w.

1279 Mine Development the Basis of Great Prosperity. Almarin B. Paul (A general letter discussing the business situation and the outlook for mining). Min & Sci Pr–Aug. 31. 3000 w.

*1293. The "Boom" in Mining Shares (Economically considered). Bank's Mag, Lond –Sept. 5000 w.

MUNICIPAL ENGINEERING

Street Subways for Large Towns.

A PAPER of value was read recently by Mr. Charles Mason before the Society of Engineers, Manchester, Eng., an abstract of which appeared in *The Gas Engineer's Magazine.* The author first criticises the old-fashioned way of laying underground pipes, in which periodical inspection of the mains for "ascertaining their condition or for stopping leakages is almost impossible." Especially is this the case with gas and electric mains, "and recent explosions in London and other cities" have rendered it a duty to adopt a better system, whereby material of whatever nature laid underground can be easily examined from time to time. The construction of subways is the most satisfactory and, in fact, the only method of so laying pipes and mains that these conditions can be complied with. The frequent disturbance of pavements, now so great an inconvenience, could be largely avoided by the use of subways. In fact, nothing could be more unsatisfactory than the present system, although the author is free to admit that any remedy is attended with many difficulties unknown to the ordinary observer. It is now almost an axiom in building that "no pipe must be out of sight," and any one erecting a house and burying the supply of waste-pipes in brickwork or plaster, or by other means making them inaccessible, is looked upon somewhat as a "jerry builder." The same law should apply to the streets, for what is lost to the holder in case of a desired examination for an escape is also lost to the ratepayers in examining an underground main. Undetected leakages may also—and often do—exist for long periods, some one suffering thereby, as for example: (1) the householder, in the case of a leakage from the water main into the basement; (2) the water company, from loss of water; (3) the gas company, from losing gas, as the condition of the subsoil of streets freely proves; (4) the public generally, from risks incurred in using the streets.

The design of a subway involves the following considerations: (1) the number and size of mains likely to be laid in at the time it is constructed and in future time; (2) ample space for workmen; (3) placing pipes in such manner as to afford facilities for repairs and connections; (4) provision for sewer inspection and ventilation; (5) provision of light and ventilation for the subway proper; (6) planning to avoid crossing the subway service pipes; (7) provision for proper fall of gas and water pipes; (8) water-tight overhead construction; (9) provision for street appliances and fixtures, such as lamps, fire hydrants, etc.

The author describes a scheme for a subway design which is intended to meet all the above requirements, of which scheme the following is an outline.

A triple subway is to have a central avenue for the trunk mains and sewer, and subsidiary or supply subways on either side for the smaller pipes from which are taken the house connections. The central avenue is 10 ft. wide by 6 ft. 3 in. high, with a segmental arch over, the subsidiary subways being 6 ft. wide by 6 ft. high. The whole is constructed in cement concrete, with brick arches and glazed brick facings throughout. Vaults are provided beneath the footways, which should be the property of the authorities and leased to adjoining occupiers. The author makes a strong point of this, as in many cases the fact that the vault construction is private property prevents the public authorities from making satisfactory repairs to the footpath. A tramway is provided in the central subway for carrying materials. The public sewer is placed beneath, with manholes at stated intervals, the house drains passing from the inspection "areas" in the vaults to the sewer in the ordinary manner. Gulleys are provided in the floor of the subway to receive washings, and for the discharging of the water mains.

The street gulleys to are be placed over spandrels formed by the vault construction, piers being built for encasing them where necessary. The outlets from these gulleys are carried down through the subway construction into the sewer, and are also carried up to the footway pavement for inspection and cleansing. An asphalt damp course is laid over the arching, outlets for the drainage thereof being provided at intervals in the springing, and connected therefrom to the sewer below.

The sideways are approached from the central way by arched openings, 4 ft. wide, in the division walls. The whole construction is covered with concrete floated to the contour of the roadway to receive the paving. Light and ventilation are procured by means of overhead gratings opening into the roadway, and special openings for this purpose are provided at regular intervals. The sewers must not be ventilated into the subway; special means are provided for this ventilation by pipes taken from the sewer and carried up to the adjoining buildings, or connected with the external air independently of the subway.

Street lamps and water posts are fixed on the footways over the spandrels of horizontal arches, stoneware pipes being built in from the bases of same to the subsidiary subways for the reception of the gas and water supplies, which can be drawn through these pipes when repairs are required. The large trunk mains rest upon sleeper walls, and the smaller ones are carried upon brackets built into the wall or attached to the overhead arching; these latter carry the telegraph, telephone, and lighter wires. All the pipes are placed at a distance from the wall so as to allow for junctions, valves, and connections; special passages or chases, about 12 in. by 9 in., are left in the vault walls for passing through the services; these passages can be closed by suitable blocks or other means at each end.

Street fire hydrants must be placed in position similarly to the lamp columns, it being essential for them to be readily accessible from the road surfaces. Should it be necessary and desirable to construct electric transformer chambers for the high tension cables, these can be placed in arched openings in the division walls of the subway; but in the author's opinion all transformers should be entirely upon the property of the company owning the same.

Special entrances are to be constructed for the reception of pipes and other materials, and these can be arranged where side streets and courts abut upon the main street in which the subway is placed.

Welsbach Burners at San Jose, Cal.

BEFORE the Pacific Coal Gas Association at its recent meeting Mr. E. C. Randall read a paper recounting his experience with the Welsbach burner in San Jose, Cal. It is evident from this paper that electric lighting has met with a powerful competitor in gas burned in the improved Welsbach burner. Mr. Randall encountered much prejudice and many obstacles in introducing the system. There are "two electric lighting companies" in San Jose, "one operated by the gas company, which was compelled, owing to opposition, to sell its current at a low figure, as the following rates demonstrate: electric arc, 11 to 1 P. M., $1.50 and $2, respectively, per week, with one or more additional incandescents free, as the case might be. Incandescents, 16-c. p., 12 o'clock and all-night circuits, from 15 to 25 cents per week. Gas, $3 per 1000." The low current cost of illumination was not, however, the most formidable obstacle; this was "the financial objection," which was ingeniously overcome by the following proposition. Say the person to be dealt with was Mr. A. "I supplied him with lamps to duplicate his illumination, furnishing sometimes his plumbing and gas fixtures. At the end of each month, after deducting his expenses for gas, the balance was applied as part payment for lamps and fixtures, as the case might be. The results of this proposition as to his earnings have averaged from 60 to 90 days; in a few cases lamps have earned themselves out in one month; in only one case have I been caught."

"The Welsbach light has changed the condition of the illuminating companies in

San Jose. A few years ago the gas company, to protect itself, had to purchase and erect an electric plant, which put it to considerable expense; and, until the Welsbach light was introduced, progress was slow for them. To-day the opposition electric company, to protect its electricity, proposes to build a gas plant. Why? Welsbachs are too much for them. This is the first electric lighting company in the United States to employ gas as a weapon against its own industry."

Mr. Randall asserts his belief "that it is only a question of time when extra distribution and a more economical light will be required and demanded by the taxpayer," and adds that the success of the Welsbach burner for street lighting is by no means an untried or undemonstrated fact. In Europe street lighting is done extensively by this burner. In referring to his own work at San Jose, he states that he has now about forty outside lights, and that the proportion of mantles destroyed has been about the same as with those used for indoor illumination. "The gas manager should feel enthusiastic at the prospects in this field, as a firm fixture is all that is required to protect the mantles from the wind, and they are immediately a success. They can easily be protected from rain, and, with a by-pass (maintaining a small light to preserve heat), from dampness." In conclusion, Mr. Randall expresses entire confidence "in the future of the Welsbach light, if it receives proper attention," and also thinks it absolutely necessary that the gas companies of the Pacific coast act in harmony with the Welsbach Company.

Asphalt Pavements.

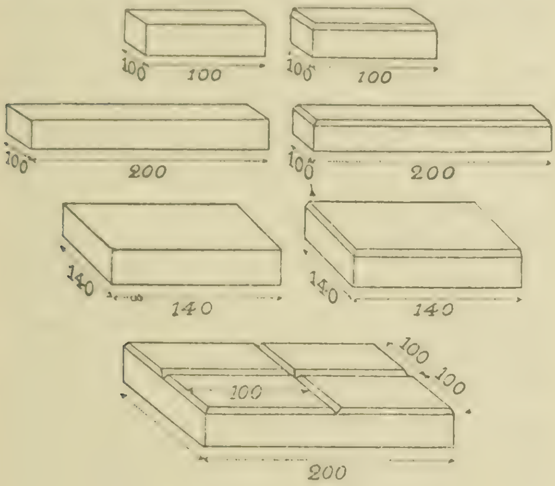
Mr. Clifford Richardson, in *Paving and Municipal Engineering* for August, says that the life of asphalt pavements depends upon the materials of which they are constructed, the skill with which they are laid, and the amount of traffic to which they are subjected. With traffic of ordinary character, the best materials, and good work in putting it down, an asphalt road should last 15 years. The pavement in front of the Arlington Hotel on Vermont avenue in Washington is cited as an example of such a pavement. If too soft cement is used, the surface soon becomes uneven; if too hard cement is used, the pavement cracks; if too little cement be used, the pavement will crack.

Mr. Richardson also points out "that the best pavements have, in addition, enemies which will destroy them, if not prevented. Water penetrating into the base and surface from the seepage of ground higher than the pavement has an injurious effect; while the escape of illuminating gas from the mains produces a peculiar and characteristic disintegration, which is readily recognized. The success with which asphalt surfaces have been maintained on some of the narrow streets of the lower part of the city of New York, with the very heavy traffic there met with, shows that, with skill in laying, asphalt pavements may be made suitable for even very trying conditions; and, as they have been maintained at such geographical extremes as New England and Louisiana, it would seem that climatic conditions do not qualify their use."

Mr. W. H. Delano, in the same number of the same magazine, writing of natural rock asphalt paving in Paris and other European cities, says it has been found that compressed asphalt is not only the most hygienic, "but also the cheapest mode of pavement; and, now that transit to the suburbs is so cheap, the working classes who pay the greater portion of the 170,000,000 francs' tax ($34,000,000) will no longer live in dear and unhealthy slums.

"Some 20,000,000 francs, or $4,000,000, is to be laid out in drainage works, so as to further reduce the death-rate within the city limits and prepare Paris for the grand exhibition of 1900, of which the buildings alone will cost 100,000,000 francs, or $20,000,000." "Wood is still being laid, but a reaction has set in against it, headed by the doctors. It has been proved to breed the microbes of diphtheria and tetanus. The putrid fibrous dust from an old wood pavement is most deleterious to the eyes and throat."

The forms of compressed asphalt slabs that have been used in Paris are shown in the accompanying engraving. Their pleasing color is said to harmonize well with that of building stone. "They are laid, like glazed tiles, on a Portland cement mortar. The hydraulic press in which they are made is fitted with an accumulator. There are two pistons, giving two successive pressures, on a revolved platform; the unmolding is effected simultaneously. The powder is heated on a kiln alongside the press. The powder is heated just as if for a street pavement."



ASPHALT SLABS. PARIS.

But Berlin ranks foremost in the use of natural compressed asphalt. It has over 1,200,000 sq. yds., about as much as in Paris and London together. A brief description and an engraving of a compressing plant for manufacturing asphalt blocks are given in Mr. Delano's article.

Sanitary Pavements.

THE *Engineering Record* (Aug. 24) says editorially that hereafter sanitary qualities will largely influence the choice of city pavements. This will be readily admitted, as this consideration has been growing in importance ever since, and even before, the now almost wholly discarded wood pavement came into use. It now has reached almost the stage of controlling consideration, at least in the better streets. It is certain that a pavement known to be of unsanitary character would have little show of acceptance in the residence districts of any large and well-regulated town. There is stated in this editorial a fact not generally known to citizens of average information,—to wit, that the air over an unsanitary pavement may be contaminated by its exhalations in the same way as air is polluted by the emanations of a stagnant pond. It says: "Recent examinations of the atmosphere in Cleveland, O., as well as considerable work of a similar character in other places, reveal unsanitary conditions of the air to which the street pavements undoubtedly contribute to a very material degree. It is, of course, obvious that the waste gases from chimneys and the vapors thrown off by sewers and in some industrial operations will by their presence directly vitiate the atmosphere, and in some cases they mny be the main sources of vitiation; but, in general, we believe that the known deterioration of the atmosphere in cities is largely produced by the unsanitary condition of the street surfaces.

"The fact has long been known among sanitary engineers that street washings are no improvement in character over ordinary sewage, and occasionally the latter liquid may have the advantage. Single block pavements, as ordinarily laid, are full of openings between the blocks, which persistently hold dirt saturated with the foul liquids of the street, and under the action of the sun the most unwholesome vapors are constantly being discharged into the atmosphere. However well laid such pavements may be, these unsanitary conditions are constantly being created with more or less activity; good work will only to a small extent remedy the evil. During the cold portion of the year these effects are largely mitigated, but not removed, while attacks of diseases peculiar to cold weather find favorable physical conditions of the population induced by the active unsanitary conditions of the preceding hot weather. The continuation of these circumstances year after year extends the foul saturation to the earth under the pavement, and intensifies the polluting effects of the whole mass on the atmosphere."

It is alleged that in many parts of New York city the street paving is unsanitary, and the prevalence of diseases like grippe and pneumonia, which have been almost, if not quite, epidemic at times, may be, in a great measure, thus accounted for. In conclusion, "an impervious pavement kept clean" is the only street surface that can be called sanitary. Bricks or blocks the joints of which are made tight by an asphalt filling, or an asphalt pavement pure and simple, would meet the necessary conditions.

Specifications for Paving Bricks.

PAVING AND MUNICIPAL ENGINEERING says the best plan is to definitely state the tests to which the sample bricks submitted by different bidders are to be subjected. The specifications should definitely state the maximum and minimum sizes acceptable. The required tests of absorption, transverse strength, abrasion, impact, rattler or tumbling, these and other tests should be minutely described and the requirements stated. It is a well known fact that some brick manufacturers make several qualities of bricks as well as bricks with several names, which, taken in conjunction with the fact that the products of the same kiln are not always alike, demonstrates at once why definite tests should be named in specifications and not the names of the bricks acceptable to the city. This is done in most materials of engineering and building construction and should, without doubt, apply to the materials of pavements. Tests should be made before the work is begun and at short intervals during the work.

IN *Paving and Municipal Engineering* for September, Mr. Fred. A. Krummer, C. E., says that while cleanliness is a result apparent since Col. George E. Waring, Jr., has been at the head of the street-cleaning department, the results are yet not all that might be desired. One of the causes for deficiencies which have been removed is the ubiquitous ash-barrel "over-flowing in its exuberance of dirt and refuse, making the condition of the city a most unsanitary one. The department has, however, been greatly hampered in its work by political restrictions, the result of long years of ring bossism, which, in so many cities, hangs like a great millstone around the neck of good government. . . . The ridiculous agitation raised by the Grand Army of the Republic, recommending Colonel Waring's removal from office, has not prevented people from recognizing the value of his work."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Technica Journals—See Introductory.

*703. The Heating Value of Coal Gas. Ill. David Voss, with Discussion. Read at Asso. of N. British Gas Managers (Dulong's calorimeter and worm calorimeter sufficient and most convenient for determining calorific value of gas). Gas Wld-Aug. 3. 2500 w.

*704. Gas Making from Splint and Shale, and from Splint and Oil Compared. A. Waddell, with Discussion. Read at N. Brit. Asso. Gas Managers (Practical experience). Gas Wld-Aug. 3. 4000 w.

706. Wrinkles. Ill. T. R. Parker, at the Pacific Coast Gas Asso. (Deals with a long list of practical matters relating to gas manufacture). Am Gas Lgt Jour-Aug. 12. 4000 w.

707. One Year's Experience with Welsbach Burners. E. C. Randall, with Discussion highly favorable to their use for street illumination. (Pacific Coast Gas Asso). Am Gas Lgt Jour-Aug. 12. 4200 w.

*719. Hydraulic Stoking Machinery in Gas Works. A. S. Biggart (Progress and present status of this system in a number of the most important English and European cities. Discussion Inst. of Mech. Eng. at Glasgow). Eng, Lond-Aug. 2. 2000 w.

*1003. Installation of Carburetted Water-Gas at Tottenham. A. E. Broadberry (A popular exposition of the differences between water-gas and ordinary coal-gas; the reasons for its adoption at Tottenham, and a description of the installment, alleged to have given great satisfaction). Gas Eng Mag-Aug. 10. 3300 w.

*1082. On the Illuminating Value of the Various Constituents of Coal and Oil Gas and Conditions Necessary to Produce Incandescence. W. Ivison Macadam (Discussion with analyses of London gases). Gas Wld-Aug. 17. 2300 w.

*1235. The Windsor Street Works of the City of Birmingham—Gas Department (Description of plant used. Interesting on account of variety of plans adopted). Eng, Lond-Aug. 30. 2500 w.

1261. A Fuel Gas and Air Mixer (Apparatus for mixing gas with a certain quantity of air before burning. Automatic). Am Mfr & Ir Wld-Sept. 6. 400 w.

1276. Incandescent Gas Lights in Exposed Positions (Relates experience of the engineer of ths Margate Gas Works, as recorded in a systematic series of notes comprising observations on effect of fogs upon the durability of mantles). Jour of Gas Lgt–Aug. 27. 1000 w.

Sewerage.

*691. Future Methods of Sewage Purification. W. L. Hedenberg (Excellent results of the electric system). Eng–Mag–Oct. 3500 w.

921. The Sewerage System and Sewage Farms of Paris, with Editorial. Ill. (A Comprehensive description of the Paris sewers and sewage farms, both past and future). Eng News–Aug. 22. 8000 w.

933. The Glasgow Sewage Works. Ill. (An exhaustive, detailed description). Engng–Aug. 16. Serial. 1st part. 1500 w.

964. Sewage Disposal at North Brookfield, Mass. Ill. (Detailed description of a system designed primarily to remove factory wastes, the removal of house sewage being a secondary consideration. Eng Rec–Aug. 24. 1100 w.

*1080. Eccles Corporation Sewage Works (Disposal of sewage by plant consisting of settling tanks and irrigation farm). Ill. Eng, Lond–Aug. 23. 1000 w.

1215. Steam Shovels for French Excavation and Backfilling. Ill. (Short description of two self-propelling machines possessing valuable features). Eng News–Sept. 5. 400 w.

1248. Proposed Drainage System for the City of New Orleans (The raising of surface drainage water by pumps, as the surface is below the river high-water mark. Map, profile and section of proposed canal. The cost will approach eight million dollars). R R Gaz–Sept. 6. 1500 w.

Streets and Pavements.

822. Surface Drainage and Natural Water Courses in Boston, Mass. (An instructive abstract of a report by Henry B. Wood, executive engineer of the Street Department). Eng Rec–Aug. 17. 2700 w.

960. Sanitary Pavements (Editorial. Sanitary qualities in pavements will be registered in the future. Why some pavements become and are unsanitary). Eng Rec–Aug. 24. 600 w.

1033. Macadamized Streets. Ernest McCullough (Model specification). Eng & Con–Aug. 23. 1000 w.

*1102. Paving Brick Tests and a Proposed Method of Drawing Specifications. L. C. Sabin (Discussion of two new tests with diagrams). Pav & Mun Eng–Sept. 1400 w.

*1103. How the Streets of New York Are Cleaned. Fred. A. Kummer (Description of the organization and work of the street cleaning department). Pav & Mun Eng–Sept. 1700 w.

1210. Asphalt Pavements as a Problem in Engineering. S. F. Peckham (Interesting information and details). Eng News–Sept 5. 1900 w.

1212. Backfilling Trenches in Streets. S. Whinery, with Editorial (Discussion of best practice). Eng News–Sept. 5. 2700 w.

Water Supply.

801. Report on Defects in the Queen Lane Reservoir, Philadelphia (Results of an examination by John C. Trautwine, Chief of the Phila. Bureau of Water, Rudolph Hering, and Maj. C. W. Raymond, U. S. A. All members of the Am Soc. C. E. $250,000 is the estimate for needed repairs). Eng News–Aug 15. 2000 w.

803. Flood Overflow of the Sweetwater Dam. Ill. H. N. Savage (Location; plans for reconstruction). Eng News–Aug. 15. 1200 w.

805. A Water Supply for Jersey City (Plans; specifications, etc). Ill. R R Gaz–Aug 16. 1200 w.

961. Scraping Small Water Pipes (A new device for cleaning foul and obstructed water pipes). Eng Rec–Aug. 24. 500 w.

963. The New Croton Aqueduct and Storage System. Ill. (History and detailed description). Eng Rec–Aug. 24. Serial. 1st part. 3300 w.

1084. Washington's Water Supply. Ill. (General description). Fire & Water–Aug. 31. 1100 w.

*1106. Filtration of Municipal Water Supplies. George H. Elliot (Description with method of removing bacteria). Pav & Mun Eng–Sept. 1300 w.

1206. Removal of Iron from Ground Water at Charlottenburg (Method of removing iron from water to prevent clogging of filtersin water supply plants). Eng News–Sept. 5. 400 w.

1207. The New High Service Water Supply of Manchester, N. H. Ill. (Brief description of new works). Eng News–Sept. 5. 700 w.

1213. The Elevated Water Tank at Fairhaven, Mass. Ill. (Detailed description and detail drawings). Eng News–Sept. 5. 800 w.

*1257. The New Berlin Waterworks (A popular description of a justly commended system of water supply). San Rec–Aug. 30. 900 w.

*1268. The London County Council and Water Supply (Editorial. A scheme to supply London with water from North Wales. System to compose reservoirs, 150 to 175 miles of covered aqueducts with a capacity of 200 million gallons per day, costing about 190 million dollars. Discourages the scheme on the ground of economy). Engng–Aug. 30. 4200 w.

Miscellany.

820. The Preservation of Natural Parks. Eng Rec–Aug. 17. 500 w.

821. The Transportation of Heavy Cables Through City Streets. Ill. E. P. Frederick (Interesting and complete description of methods and apparatus designed by the Broderick and Bascom Rope Company of St. Louis, Mo). Eng Rec–Aug. 17. 4800 w.

825. Philadelphia's Fire Houses. Ill. (Descriptive of what is claimed to be the most complete and probably the largest fire station in the world). Fire & Water–Aug. 17. 1500 w.

962. The City and the Engineer. A Paper by Robert E. McMath, reprinted from Trans. of Asso. of Civ. Eng. of Cornell Univ. (Municipal affairs and organization and the engineer's place and function therein). Eng. Rec–Aug. 24. Serial. 1st part. 3500 w.

*1094. Destruction of Town Refuse. Ill. (Description of plant). San Rec–Aug. 23. 1000 w.

RAILROADING

London to Aberdeen.

MR. CHARLES ROUS-MARTEN in *The Engineer* gives an interesting summary of "the decisive and final phase" (beginning Monday, August 19) of the recent great railway race noticed in this department for September. Some particulars of the distances traversed by the rival trains, and other details of the race, were presented in the review referred to. "The noteworthy point" in this final phase was that in the increase of speed, noted below, and the carrying out of "a timing which seemed phenomenal, and which not long ago would have seemed impracticable, if not impossible, the locomotive resources of the companies were never overstrained; indeed, were never taxed to their utmost. The actual arrival time at Aberdeen on Monday was 5.31, or 9 minutes early," the schedule time being 5.40 A. M. and the proposed time from London to the Aberdeen station being 9 hours and 40 minutes. "But, then, 20 minutes had been absolutely wasted in delays at Dalton, Edinburgh, and Dundee," due to various avoidable causes, and 2 minutes were otherwise lost by avoidable checks between stations; so that it appeared to be demonstrated that the run could be made in 9 hours and 8 minutes without quickening the actual speed. In fact, the time was reduced to 9 hours and 11 minutes on Tuesday. "But, just as the West Coast had beaten the East by 16 minutes on Monday, so it did on Tuesday, reaching Aberdeen ticket platform at 4.58, or 8 h. 58 min. from London. So arrangements were made for a fresh acceleration on the East Coast on Wednesday, which it was believed that the West Coast, with its extra 17 miles of distance and heavier grades, could not possibly equal.

"The quickening began from the outset. Potter's Bar Summit (12¾ miles) was passed in 15 minutes from the start, nearly 2 miles of the distance being on a rise of 1 in 105 and 1 in 110, and more than 8 at 1 in 200. Hatfield (17¾ miles) was passed in 19½ minutes, Hitchin (32) in 33, Huntingdon (58¾) in 55½, Peterborough (76¼ in 72. The 23¾ miles back to Stoke Summit were ascended, after the slack through Peterborough, in 24 minutes, and Grantham (105¼) was reached in 101 minutes, or in 29 minutes from Peterborough. Starting again from Grantham, Newark was passed in 14 minutes for the 14¾ miles, Retford (33¾) in 30½, Doncaster (50¾) in 46 minutes, Selby (69) in 62, and the arrival at York (82¾) was in 76 minutes. The engine from London to Grantham was No. 668, and that from Grantham to York No. 775,—both the same as on the Monday and Tuesday night, and both being of the older class of 8 ft. 1 in. singles. It will be observed the average speeds were 63.3 from London to Grantham, and 65.5 from Grantham to York, and that the entire run from King's Cross to York was made in 3 hours one minute, including stoppage, or in 2 hours 57 minutes actual running time. The North-Eastern now took its turn, and did its part admirably. A fine run of 79 minutes was made to Newcastle (80½ miles) by No. 1621, a new 7-ft. coupled bogie; but the ensuing rush to Edinburgh, 124½ miles, at the average rate of 66 miles an hour by No. 1620, was quite the sensation of the East Coast run. It delivered the train at Edinburgh at 2.19 a. m., or in 6 hours 19 minutes from London. This makes the 7 hours 26¾ minutes, which constituted the record in the race of 1888, look very small indeed. The North British Company now took on the train, and did some extremely fine work, when the difficulties of the road are taken into account. Dundee, 59¼ miles, was reached in 59 minutes, and Aberdeen ticket platform, 71¼ miles, in 76 minutes, the train arriving at the platform by 4.38, and entering Aberdeen Station at 4.40,—*i. e.*, in 8 hours 40 minutes from London."

In these runs, had the load been reduced to 50 or 60 tons "for racing purposes," a very large saving of time would have been practicable. This was proved in the final rush of the entire racing period, when with a load "reduced to three bogie coaches, weighing about 68 tons in all, ... the Northwestern and Caledonian engines accomplished the fastest long-distance run in all railway annals, not merely beating the East Coast record by 8 minutes, but running 17 miles longer distance to do it; and it is noteworthy that for the whole of that extra 17 miles the West Coast gradients are from 1 in 88 to 1 in 75, and even 1 in 70,—the last being just out of Euston. This accentuates the wonderful character of the feat, which even the extreme lightness of the load does not deprive of its marvelous character."

Stimulated probably by this splendid record, and anxious to beat it, the New York Central and Hudson River Railroad Company, on the 10th September, ran the express train commonly known as "*The Flyer*" from New York to Buffalo at an average speed, exclusive of stops, of 64.34 miles an hour, thus beating very slightly the English record for actual running speed. The following is a record of the run:

New York	Distance.	Time.
Albany	143 miles	134 minutes.
Schenectady	17 miles	19m. 14s.
Utica	78 miles	71 minutes.
Syracuse	53 miles	49m. 30s.
Rochester	80 miles	73 minutes.
Buffalo	65½ miles	60m. 16s.

Total distance from New York..436½ miles.
Total time.................. 407 minutes.
Average time, exclusive of stops, 64 1-3 miles.

The train was, however, very much heavier than the English train. The weight was 270 tons, and the train had accommodation for 218 passengers. Moreover, it is said to have run the entire trip against a strong head wind.

The Wear of Driving-Wheel Tires.

THE committee appointed by the Master Mechanics' Association to investigate the above subject have issued their report, an abstract of which is printed in *The Railway Review* (Aug. 17). The information was drawn from measurements of irregularities of wear of tires at the shops of three large western roads, covering periods of 5 and 22 years (in case of Union Pacific Railroad). "The report is divided into three parts, treating: *first*, the nature, location, and extent of the irregularities in the wear of driving-wheel tires, the methods employed in measuring and recording them; *second*, discussion of the forces causing the wear in tires of the eight-wheel and ten-wheel type of engines; *third*, deductions and conclusions." After going over the results in detail and illustrating them with diagrams, drawings, and tables, the article says that "there are two locations of maximum wear, one beginning at about 160 deg., reaching its maximum at about 220 or 230 deg., the other becoming pronounced at from 10 to 20 deg., and reaching a maximum at 50 deg. Both of these low points are connected from 220 to 50 deg. with the direction of rotation by a portion of the tire much more worn than that from 50 to 220 deg. To understand this, it must be seen that slight slipping through a small part of the revolution occurs usually on heavy pulls at slow speed, the beginning of the slip in this case occurring at the maximum of the coefficient of slip. At 20 miles per hour the coefficients are at a maximum at 40 to 130 deg. . . . . At 100 deg. the pressure on these wheels was almost at a minimum, and is much less than from 140 to 160 deg. The wear following 160 deg. is greater than that following 40 to 50 deg. for the same reason. The same conditions as to rail pressure occur for the left forward and back wheels 90 deg. back of those on the right side, and irregularities of the wear produced by the drivers slipping at considerable velocity should occur on the left wheels at points 90 deg. back of the corresponding points on the right wheels, or at 310 deg., and at 130 and 140 deg. . . . .

"There is no doubt locomotive tires wear without slipping, and there should be, and probably is, a portion of the irregular wear due to the pulverizing or crushing action being greater under heavy than under light loads. The experiment made by removing all the overbalance in the counterbalance of C. B. & N. Engine No. 150, when the irregularities of wear in the main wheel were almost exactly duplicated in location, and to a remarkable degree in magnitude, together with similar experiments attended by the same general results, and the fact that switch-engine tires wear more evenly than even slow road engines, lead us to believe that their irregularities of wear are almost wholly caused by abrasion from slipping, and that the pulverizing of the steel from pressure alone is but of very minor importance. In conclusion, the committee was of the opinion that it is absolutely impossible to entirely avoid the irregular wear of locomotive tires in ordinary road service, and which is aggravated by sandy track, since these irregularities are due very largely to inequalities in the pressure of the driving wheels on the rail and the rotative force at different parts of each revolution, which are unavoidable in our present locomotive construction, and probably not entirely avoidable in any steam locomotive with reciprocating parts. They also believe that these irregularities of wear can be considerably reduced by the careful design and operation of our present type of engine, and would to this end recommend the observance of the following:

" (1.) Driving wheels should have ample weight for adhesion. (2.) Main rods should be as long as is consistent, in order to decrease the effect of angularity. (3.) The weight of the reciprocating parts, and consequently the overbalance in the driving wheels, should be as light as possible. (4.) As small a proportion of the reciprocating parts should be balanced as is consistent with smooth working machinery and good riding conditions. (5.) The driving boxes, shoes, and wedges should be well maintained and kept properly adjusted. (6.) Have a careful and competent engineer in charge who will avoid slipping the drivers."

The diagram illustrations used in the article to show relation of pressure on rail to revolution were made on an instrument devised by Mr. W. H. Lewis; it resembles somewhat the ordinary engine indicator.

Principles of Block Working.

OWING to recent discussions on the relative merits of American and English methods of block working, the attention of railroad men has been directed to the matter, with the hope that some way may be found to relieve the present practice of uncertainties arising principally from the personal equation of the operators. There is no system of checks by which all signals can be verified otherwise than by the operator himself. Mr. A. A. Anthony has taken up the discussion of this subject in *The Railroad Gazette* (Aug. 16). He classifies present practice as follows: " There are two simple methods of block working, each of which is in use, I believe. Under the one plan *C* (in a system of three block stations *A*, *B*, and *C*) notifies *B* of the passage of each train out of the block *BC*, and *B* admits each train on the condition that the last train has been reported clear by *C*; that is, the blocking is based on *clearances*. Under the other plan trains are not reported clear by *C*, but *B*, when a train is approaching, asks *C's* permission to admit the train to the block; if *C* is satisfied that the last train that entered the block has passed out, he gives permission or 'accepts' the train; *B* then gives a 'clear' signal. So we may say that the blocking is based on *acceptances*."

It will be at once seen that much depends upon the memory and vigilance of the operator. He may not only give a wrong signal under a mistaken impression, but may send signals to other than the proper stations, and even enter signals on his records in wrong columns. When running is very regular, he may accept trains from force of habit. Where the *clearance* and *acceptance* systems are used in conjunction, "a wrong 'clear' signal will not be given, unless errors on the part of both signalmen *coincide*." After taking up all possible cases likely to occur, the author arrives at these conclusions.

" (1.) It is essential that each train that passes out of a block should be reported by the signalman at the end of the block to the signalman at the beginning. (2.) The giving of a 'clear' signal, or its equivalent, for a train to enter a block, should depend upon the condition that the last train that entered has been reported 'out' in the regular course. (3.) The giving of a 'clear' signal, or its equivalent, for a train to enter a block, should depend upon the permission of the signalman at the end of the block. (4.) A permission given for a train to enter a block remains in force until a train comes through that block. (5.) The giving of a permission for a train to enter a block should depend upon the condition that no previous permission is in force."

Electric and Steam Tugs-of-War.

As to the frequent reports of tugs-of-war between electric and steam locomotives, in which, by the way, the latter are invariably declared victors, the *Railroad Gazette* has something pertinent to say. After alluding to the reports in the daily papers, "which are supposed to know no better," and to some electrical journals "that ought to be more correctly informed," it puts the case in this way: "Broadly speaking, such tests are no possible criterion of the relative merits of the electric and steam locomotive. Provided each class of locomotive possesses sufficient power to slip its drivers, the heaviest machine will always win, regardless of the kind of power employed. The latest test of this character was made on the Nantasket Beach road. A heavy train was made up, to one end of which was attached a steam locomotive and to the other an electric motor, and it is stated that, when both were working to their full capacity, the electric machine pulled the steam engine and the train without trouble. All of which simply means that the electric locomotive, because of its heavier weight, possessed the greater tractive power. There are, of course, many other questions than mere pulling capacity, which must be considered in determining the relative merits of the steam and the electric locomotive, and neither should be declared the superior of the other because an engine weighing 60 tons, operated by one power, exerts a greater tractive force than the other machine, weighing 50 tons, driven by the other." This throws a deal of light upon a popular misconception of facts. There is no doubt whatever as to the powers of electric locomotives of the Baltimore and the Nantasket types,—to say nothing of what is coming,—but there is no sense in further disparaging that useful, well-tried animal, the iron horse.

Lack of Tramway Progress in England.

"WHY is it," the *Railway World* plaintively inquires, "that tramway progress is almost unknown in the British Isles, while elsewhere, even in other European communities, it is one of the most noticeable features of the past ten years?" Answering its own question, the *Railway World* justly remarks that it is certainly not because English engineers are wanting in skill or enterprise; the few opportunities granted to them at home have been successfully employed, and their achievements compare favorably with modern tramways elsewhere. It also calls attention to the various schemes of underground railroads in various stages of progress or completed in London, to attest that in one direction at least there is no lack of enterprise. "To find the real reason for our lack of progress we have to go to the legislative and official discouragements that hedge about the promotion of tramway projects. There is every reason to believe that the tramway industry would, if properly encouraged, prove as active in England as in America; but it must be able to employ the latest improvements in methods of traction, and to enjoy concessions as liberal as those granted to it elsewhere." There may also be something in the conservative habits of the British public, and the *Railway World* must have had this in mind when it adds that it is clearly the duty of tramway companies, and of all those interested in the promotion of tramway enterprise, to educate public opinion on the subject so that the restrictions which have so long retarded progress may be swept away. But how this is to be accomplished is not indicated.

Railroads Making More Money.

WITH the dread tales of ruin and national bankruptcy still in the air, we turn to the following from the *American Manufacturer*, given as an indication of coming prosperity in business: "A summing-up of the railway earnings, as given by *Bradstreet's*, shows that the gross earnings of 145 railroad companies for the first 6 months of 1895 aggregate $349,099,773,—a gain of 3.6 per cent. over the corresponding period of 1894, which in turn showed a decrease from 1893 of 16.4 per cent. The net earnings of the same roads for this year aggregate $102,767,786,—a gain over last year of 8.1 per cent., and following a decrease in 1894 from 1893 of 18.8 per cent. An examination of the record 1 year ago shows that every group of American railroads showed decreases in gross receipts, varying from 10.4 per cent. in the case of the southern roads to as much as 21.5 per cent. for the southwestern roads. Decreases in net earnings were even more strongly marked, varying from a falling off of 7.4 per cent. in the case of the granger railroads to as much as 40.6 per cent. in the case of the southwesterns. This year the exact opposite may be said to be the case. It is true, there are some decreases in gross earnings this year from last,—notably in the case of the southern and granger railroads,—but there are also notably large increases in nearly all the other groups." The editor then continues: "That the enlarged business has been accompanied by careful management in the operating department is proven by the fact that, while gross earnings this year gained 3.6 per cent. over the first 6 months of 1894, the gain in net is relatively more than twice as much,—8.1 per cent."

Railroads are in such close sympathy with the industries and resources of our country that what affects one speedily affects the other. If railroads are making money, the shippers are making money, and, as the article rightly concludes, the outlook is for prosperity and an accumulation of wealth in the near future.

Needed Uniformity in Car Construction.

THE *Railway Master Mechanic* for June urges upon the attention of the Master Car Builders' Association the need of an agreement upon a system of "a reasonably correct distribution of the material and upon standard sizes for the principal timbers" in railway cars. It asserts the belief that "no more sensible work could be undertaken" by this association during the coming year.

The subject is treated as involving "problems of great importance to railroads and officials upon whom the responsibility directly falls. Aside from the framing of suitable rules of interchange, the one thing which would most facilitate interchange, and at the same time reduce the cost of freight-car construction, is the adoption of a standard freight car. This has been proposed a number of times, but we must admit that there appears to be very little disposition on the part of the various railroad companies or their master car builders to take this important step."

A table of the finished dimensions of the principal timbers in the freight cars of nine large railroads is presented. A study of this table discloses a considerable uniformity in some particulars, and a remarkable diversity in other respects. Length and width do not differ so much as expected. A conclusion reached from the drawings from which the table has been compiled is that "with one or two exceptions the amount of material used in the different cars does not vary greatly, and the different dimensions of parts arise more from a difference in the distribution of the material."

Present Practice in Railway Signaling.

AT the present time, when every accident draws a very serious amount of money out of our railways' already slim profits, it has become a matter of economy for them to adopt all known efficient safety appliances. In order to ascertain exactly what devices are actually in use, *The Railway Review* (Aug. 17) gives the results obtained by sending out questions to seventy-five principal railroads in English-speaking countries and colonies. These are very important, and show a remarkable uniformity in practise. However, "the great railway system of the United States, with 176,000 miles of road and 900,000 employees, and a passenger service unequalled in any other part of the world, cannot be placed in a leading position so far as its safety appliances are concerned. . . . The total mileage of railways in Great Britain and Ireland is about 20,500; in India, about 18,000; and the Cape railways have a total mileage of 2635. In Australia there are about 12,000 miles, and in Canada about 14,000. In Great Britain and Ireland and the colonies the semaphore signal is universally employed as a main line signal, the disc signal being used only for sidings and shunting operations. In the United States thirty-four out of thirty-six companies were in favor of the semaphore, although the disc signal is used in connection with automatic systems, such as the Hall. In Great Britain, Ireland, and the colonies the 'danger' light for main line systems is universally red, and, as a rule, the 'all clear' light is green; a number of companies still use white as an 'all clear' signal, but it is likely that white will be wholly abandoned, and, when seen, will be treated as a danger signal. No caution signals are used there. The ground disc signal is more largely employed for sidings than any other form in Great Britain and its colonies, but some companies prefer dwarf semaphore signals. A few lines, such as the London and Northwestern Railway of England, use a purple light as a danger signal for sidings. In Great Britain and Ireland and the colonies distant signals are universally used. These are placed at distances varying from 300 to 1700 yds. from the home signal, but the general rule is to place the signal at about 800 yds. from the home signal on a rising gradient, and on a falling gradient from 1000 to 1200 yds. distant. Signals in England are, in a few cases, worked successfully by wire connections over distances of more than a mile, but as a rule it is not considered desirable to exceed 1200 yds.

"In England and Ireland and the colonies separate signal posts are provided for each signal arm in cases where one or more branches lead from the main line, these separate posts being in many cases carried by brackets, the more important signal being somewhat raised above the others for the sake of distinction. This practice applies to running tracks only, and, in the case of signals for subordinate tracks in the rear of the junction, it is the general practice to provide one signal post, and to place the several arms one above the other. It is the invariable practice of Great Britain that the top arm governs the left-hand line. The second arm governs the next in order, and so on. On all British railways it is the general rule to provide an independent distant signal for each home signal. As a rule, in Great Britain, the colonies, and the United States the only distinction that is made in the signal for a freight track running parallel to a main line is the provision of a ring on the arm, which is, as a rule, carried at a lower elevation; but no difference is made in the night signaling. Back lights are universally used to enable the operator to see whether the signal is lighted. In Great Britain it is the general practice to show a white back light in the 'danger' position of the arm, and in the 'clear' position the light is obscured . . . The tappet type of locking is the form most generally used . . . . Detector bars are used in Great Britain to some extent, to enable the operator to determine the presence of cars on lines which are out of his sight. In Great Britain derailing switches are commonly used on sidings; they are also used there on falling gradients."

After speaking of the application of power to signals, automatic torpedo apparatus, absolute block systems, the Sykes system, switch regulations, color-blindness tests, and devices not generally known, the article concludes thus: "In comparing the work accomplished in Great Britain to that of the colonies and the United States, it was found that in Great Britain little remains to be done further than perfecting details." This question was fully discussed before the fifth section of the International Railway Congress by Mr. A. M. Thompson Mr. H. Raynor Wilson adding some notes on recent improvements.

The Condition of American Railways.

THE *Railway Review* (Aug. 31) publishes some advance statistics from *Poor's Manual for 1895*, which are interesting by reason of the accurate figures on the condition of an industry upon whose development the growth of many other industries depends. The effect of depressed trade has been keenly felt and immediately evidenced by the transportation lines. The table below gives a general summary of the results of the operations during the past two years.

	1894.	1893.	Rate of Incr'se or Decrease.
Miles R R. Operated	175,444.11	173,370.07	1.19
Tons Freight Moved	675,129,747	757,464,480	10.85
Freight Mileage ...	82,289,400,498	90,552,087,290	9.12
Passengers Carried.	583,248,007	628,965,973	7.25
Passenger Mileage..	13,600,531,635	15,146,711,952	10.20
	$	$	
Earnings fr. Freight	700,477,409	808,494,668	13.36
Earnings fr. Pass'gr	276,031,571	311,978,342	11 52
Miscel. Earnings....	91,134,533	88,168,488	3.36
Earnings, "L" R'ds.	12,661,502	13,976,792	9.41
Total Gr. Earn's ..	1,080,305,015	1,222,618,290	11.64
Net Earnings........	322,539,276	364,591,109	11.53
Earn. per T. per M..	0.851 cent.	0.893 cent.	4.70

"The following statement shows that, notwithstanding the steady increase in the average capitalization (share capital and bonded indebtedness combined) per mile of railroad, the average of such capitalization on the basis of total track mileage is being rapidly lowered, the decrease in this respect in the past 20 years having been about 5 per cent. as against an increase on basis of road mileage of nearly 2 per cent."

YEARS.	RAILROAD.		Total Stock and Bonds.	STOCK & BONDS PER MILE OF—	
	Total RR.	Total Track.		Rail-road.	Tr'ck
	Miles.	*Miles*	$	$	$
1875......	74,096	91,611	4,400,869,412	59.394	48.038
1885......	127,729	160,597	7,583,424,898	59.371	47,220
1890	163,420	208,303	9,746,141,603	59,639	46,788
1894......	178,119	232,919	10.741,363,319	60.315	45,686

Figures for the financial years quoted are for fiscal years ending at various dates. However for the purposes of comparison with other years the figures are sufficiently close.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Technical Journals—See Introductory.

*694. Mountain Railroads in Mining Regions. Ill. James R. Maxwell (Problems in difficult engineering). Eng Mag-Oct. 3500 w.

*712. The Railway Race to the North (Editorial. East and west coast routes ; London to Aberdeen ; great acceleration in speed). Engng, Lond–Aug. 2. 3500 w.

*724. Signals at Liverpool Street Terminus. Ill. (Arrangement of switches and locks). Eng, Lond–Aug. 2. 1200 w.

*735. Chicago's New Overhead Electric Railway. Ill. (Termini ; routes ; structure ; stations ; electrical equipment ; rolling stock). Ry Wld–Aug. 3000 w.

*736. McConnell Locomotives. Ill. Clement E. Stretton (A study of English locomotives, 1845-60). Ry Wld-Aug. 2000 w.

752. Automatic Couplers and Air-Brakes (Review of statistics ; criticism of new law). R. R. Car Jour–Aug. 800 w.

753. Postal Car, Baltimore and Ohio R. R. Ill. (Working drawings and details). R R Car Jour–Aug. 1500 w.

754. Handholds and Height of Drawbars (Extension of time in which to comply with the law). R R Car Jour–Aug. 1500 w.

755. Painting Freight Cars (Durability). R R Car Jour–Aug. 600 w.

756. A Pressed Steel Diamond Truck Frame. Ill. (Description of a design by Charles T. Schoen). R R Car. Jour-Aug. 1000 w.

762. The Employment of Two or Several Motors on Cars or Locomotives with Respect to Skidding. Paul Hoho (Examination from the point of view of the slipping or skidding of the wheels. Conclusions unfavorable to this disposition). Elec Ry Gaz–Aug. 10. Serial. 1st part. 1300 w.

764. Duties and Responsibilities of Station Agents (Manual issued by E. O. Hopkins of the Louisville, Evansville & St. Louis Railroad to the agents of that company for their information and guidance). Ry Rev-Aug. 10. 3400 w.

782. The Braking of Trolley Cars (Editorial reply to criticism in American Machinist). Elec–Aug. 14. 1400 w.

806. Train Policing. C. A. Wilson (Abstract of paper read at meeting of Central Asso. of RR. officers). R R Gaz–Aug 16. 1800 w.

807. Railroad Track Melted by a Stray Electric Current. Ill. (North Attleboro, Mass.) R R Gaz–Aug. 16. 500 w.

808. Principles of Block Working. C. C. Anthony. R R Gaz–Aug. 16. 2000 w.

*811. The Hall Normal Danger Signal System (Credit is given to the United States for being much in advance of England in automatic signalling. The Hall system in use on 25 American roads is there described and illustrated as an example of the progress made in this kind of signalling). Engng–Aug. 9. 4500 w.

850. Motor Cars for Chicago's North Side

Loop Lines. Ill. (Description, with reasons for introducing). W Elec–Aug. 17. 800 w.

*856. The Railway Race to Aberdeen. Charles Rous-Martin (Race between the east and west coast routes. The achievements constitute an epic in railway history). Eng, Lond–Aug. 9. 3400 w.

*860. Concentrated Loads (Editorial Comments on methods used in calculating). Eng, Lond–Aug. 9. 1900 w.

*862. Railway Problems in Victoria. View of an ex-Minister. Trans–Aug. 9. 3500 w.

883. The Present Situation in Railway Signaling (Notes compiled from answers to questions sent out by the International Railway Congress). Ry Rev–Aug. 17. 2200 w.

884. Telegraph Department of the Michigan Central Railroad. E. E. Torrey (System different from that used on most roads—The single order system). Ry Rev–Aug. 17. 1200 w.

885. The Wear of Driving Wheel Tires. Ill. (Summary of report presented at the Alexandria Bay Convention of the Master Mechanics Association). Ry Rev–Aug. 17. 2800 w.

887. The Commercial and Railroad Side of Car Service. A. L. Gardner (Read at the meeting of the National Asso. of Car Service Managers). Ry Rev–Aug. 17. 2000 w.

891. Hints on the Maintenance of Electric Railway Cars. Tito Toscani. Elec Rev–Aug. 21. 500 w.

*894. Tracks Are Private Property (Judge Tuley holds that Chicago City Railway has an easement in the street by virtue of its ordinance and contract with the city, and that its rights cannot be taken in whole or in part without compensation). St Ry Rev–Aug. 6500 w.

*927. Light Railways for the Transport of Sugar-Cane in Australasia. Charles Edward Forster (Earthworks and gradients; bridges and culverts; permanent way; rolling-stock). Ind & Ir–Aug. 16. 1100 w.

944 Freight Trains by Water (An enterprise proposing to carry freight cars on barges from Peshtigo, Wis., to Chicago). Ry Age–Aug. 23 600 w.

945. A Proposed Railway Equipment Car Pool. J R. Cavanagh, with editorial (A design to save the 25 to 40 per cent. excess of freight cars now required). Ry Age–Aug. 23. 1400 w.

946, Railway Relief Organizations in the United States. W. B. Outten (Discussion of the situation). Ry Age–Aug. 23. Serial. 1st part. 2200 w.

947. Locomotive with One Pair of Drivers. Ill. (Description and dimensions of details). Ry Age–Aug. 23. 200 w.

948. The International Railway Congress (Discussion Mr. Aspinall's paper on Express Locomotives, bringing out some local and special needs in compound and high-pressure locomotives). Ry Age–Aug. 23. 1700 w.

949. The Chicago Interchange Agreemeut (Details with names of railroads adopting it). Ry Age–Aug. 23. 1400 w.

956. Railroads Making More Money (Editorial. Statistics showing gain in earnings over 1894). Am Mfr & Ir Wld–Aug. 23. 500 w.

*978. Fireless Locomotives (The engine is charged with steam from the generators situated at appropriate stations. Description and dimensions). Prac Eng–Aug. 16. 1000 w.

*979. Heating Railway Trains by Steam and Compressed Air Combined (The system used on the Eastern Railway of France; has the advantage of keeping the pipes clear of water without wasting steam at rear car). Prac Eng–Aug. 16. 1500 w.

981. Repairs and Renewals of Railway Rolling Stock. Alfred John Hill (Results of experiments; analyses of materials and effect of wear). Ry Rev–Aug. 24. 2500 w.

982. The New Eight-Wheel Passenger Locomotive on the C. C. C. & St. L. Ry. Ill. (Complete description, drawings and specifications). Ry Rev–Aug. 24. 2500 w.

*999. The Railway Race for the North (Comments on the race between the east and west coast-routes in England). Trans–Aug. 16. 2700 w.

*1000. Forty Years of Railway Progress (Tabulated statement showing capital cost, etc., of the railways in Great Britain). Trans–Aug. 16. 900 w.

1001. Nassau Electric Railway of Brooklyn, N. Y. Ill. (Descriptive. Electrically-welded rail joints. Editorial comments). Elec Ry Gaz–Aug. 24. 1400 w.

1035. Single-Driver Express Locomotive; Philadelphia and Reading R. R. Ill. (Description with specification). Eng News–Aug. 29. 1350 w.

*1045. Right and Wrong Way to Start a Car (Illustrated by diagram). St Ry Rev–Aug. 15. 400 w.

1047. The New York Central and Hudson River Railroad—Standard Types of Permanent Way. Ill. (Sections of rails with fastenings and specifications). Sci Am Sup–Aug. 31. 200 w.

1050. Tests of Locomotives in Fast Passenger Service. Ill. (Tests of two locomotives determining relative efficiency with specifications and cards). R R Gaz–Aug. 30. 900 w.

1051. A Combination of Grafton's Signal Blades and Carter's Signal Lights (Suggestion of improvements and description of practice). R R Gaz–Aug. 30. 1800 w.

1052. The New Interchange Association (Revised agreement adopted July 30). R R Gaz–Aug. 30. 1200 w.

*1078. The Great Railway Race. Charles Rous-Marten (Comparison of time made by railroads on east and west coast of England, between London and Aberdeen). Eng, Lond–Aug. 23. 2500 w.

†1086. The Detroit Citizens' Street Railway Company. Ill. (Complete description of plant and organization). St Ry Jour–Sept. 2800 w.

†1088. The Effect of Service on Street Car Bodies. Ill. (Construction of floors and platforms). St Ry Jour–Sept. Serial. 1st paper. 2500 w.

†1089. Street Railway Rolling Stock. W. E. Partridge (General design and construction of passenger cars). St Ry Jour–Sept. 2200 w.

1107. Grabirons and Handholds. Ill. (Report of the Committee of the Master Car Builders' Asso). Ry Age–Aug. 30. 600 w.

1108. Tubular Steel Underframe for Cars (Brief description with drawings of plan and elevation). Ry Age–Aug. 30. 180 w.

*1110. The Railways of India (Earnings, traffic and general financial condition). Ry Times–Aug. 24. 2000 w.

*1111. The Railways of Ceylon (Itemized comparison of earnings in 1893 and 94). Ry Times–Aug. 24. 400 w.

*1112. 70000 Pounds Capacity Coal Car, Pennsylvania Railroad. Ill. (Description and dimensions). Nat Car & Loc Build–Sept. 900 w.

*1113. Single-Driver Locomotive, Philadelphia & Reading R. R. Ill. (Description with specifications of a compound type of locomotive). Nat Car & Loc Build–Sept. 400 w.

1136. The Victoria Nyanza Railway (Proposed route from Mombasa to Victoria Nyanza). Trans–Aug. 23. 1700 w.

*1144. Dead Weight (The designing of R R rolling stock with reference to weight and strength of bridges)). Am Eng & R R Jour–Sept. 2500 w.

*1146. Standard Cars on the Southern Pacific Railroad (Circular of the Southern Pacific Railroad Co. giving instructions for the careful determination of the merits of 1,300 freight cars built to a common standard and in use on that road). Am Eng & R R Jour–Sept. 900 w.

*1149. New Compound Locomotives for the St. Gothard Railroad. Edward Sauvage (Specification, description and drawings in section and elevation of a three and four cylinder locomotive). Am Eng & R R Jour–Sept. 2200 w.

*1150. Railway Rolling Stock. Alfred John Hill (Wear and durability of railway rolling-stock in England). Am Eng & R R Jour–Sept. 1000 w.

*1159. Norfolk and Western System of Maintaining Standards. A. S. (An attempt at uniform practice in the repair shops and a tendency to make parts interchangeable). Loc Engng–Sept. 800 w.

*1160. Blind Tires on Locomotive Drivers. D. Brown (Reasons why they are unnecessary). Loc Engng–Sept. 200 w.

*1166. Railway Enterprise in Egypt. (Report of Frederic C. Penfield, agent and consul general for the U. S. at Cairo, April 6, 1895). Bd of Tr Jour–Aug. 600 w.

*1188. The Uganda Railway (Discussion before the House of Commons by the great African explorer, H. M. Stanley). Ir & St Tr Jour–Aug. 24. 1000 w.

1194. A Proposed System of Rapid Transit for New York City (System devised by A. H. Thorp, proposing six lines of tracks around the entire city, along the water-fronts, and a central longitudinal line of four tracks). Am Arch–Aug. 31. 1500 w.

1205. The Northwestern Elevated R. R., Chicago, Ill. Ill. (A complete, concise description, with map of route and inset plate of construction details). Eng News–Sept. 5. 3000 w.

†1218. Terminal Freight Yards. W. A. Garrett (Paper read at meeting of St. Louis Supt.'s Asso). Ind & East Eng–Aug. 3. 1800 w.

†1219. Rolling Stock for Pioneer Railways. Ill. (Description of cheap and narrow gauge rolling stock used in India and S. Africa). Ind & East Eng–Aug. 3. 1300 w.

*1236. The End of the Railway Race. Charles Rous-Martin (The great railway race from London to Aberdeen). Eng, Lond–Aug. 10. 2400 w.

1241. Conclusiveness of Decisions of Engineers (Case of Mundy v. L. & N. Ry. Co. The contractor disputed excavation measurements, though the contract declared the engineer's estimate to be conclusive. The U. S. Circuit Court decides that the engineer was not an arbitrator but a member of one party). Ry Mas Mech–Sept. 700 w.

1243. Handling Scrap at the Pan Handle Shops in Indianapolis (A very efficient system as practised at the Pennsylvania shops, composed of labeled bins on platforms by the "in" and "out" tracks. The cutting up is done by a compressed air shears. Illustrated in detail). Ry Mas Mech–Sept. 600 w.

1244. The most Powerful Eight Wheeled Passenger Engine in the World. Ill. (It is built for the C. C. C. & St. L. Ry. Weighs alone 126,000 lbs., two single cylinders 20x24 in. working under 200 lbs. steam pressure. An average trip is also given). Ry Mas Mech–Sept. 2000 w.

1245. Performance of the New Passenger Engines on the Pennsylvania Railroad. Ill. (An engine approaching the mile a minute speed, and doing excellent service; it is of the 1895 design, with 18½ x 26 in. cylinders, 80 in. drivers, carrying 180 lb. pressure). Ry Mas Mech–Sept. 600 w.

1246. Equipment of a Wrecking Train. W. S. Scott (The train is composed of one derrick car, crane style; two cabin cars and flat cars, one loaded with trucks. A description of organization, tools employed and full equipment, with method of working and report). R R Gaz–Sept. 6. 800 w.

1247. The Northern Pacific and the Great Northern (A discussion *pro* and *con* of the proposed alliance of these two great roads. An editorial opinion without conclusion). R R Gaz–Sept. 6. 2000 w.

1277. Car Lubrication Extraordinary. "A Reader" with Editorial (A run of seven months without lubrication of a car on the Norfolk and Western R R). R R Car Jour–Sept. 900 w.

1295. Yard Work as Applied to Extra Switching, Including Cars for Destinations. J. Turner (Waste of time; and ways in which time may be saved in switching; advocating more systematic working). Ry Rev–Sept. 7. 2400 w.

SCIENTIFIC MISCELLANY

Fixation of Atmospheric Nitrogen.

ONE of the oldest problems in industrial chemistry is the discovery of a practical commercial method of obtaining and holding in chemical combination nitrogen obtained from the atmosphere. Dr. Francis Wyatt, in *The Engineering and Mining Journal* (August 10), states that the solution of this problem, which has been sought for 50 years, is of "immense importance to mankind." "Theoretically, and in the laboratory, the problem has long been solved. If it has not been solved hitherto industrially, and on a large scale, it is not only because of mechanical difficulties, but because experimenters have not properly understood the negative and unstable properties of nitrogen itself. The progress of science has facilitated the combination of carbon, hydrogen, and oxygen, independently of nature, and has taught us to build up from them, synthetically, many organic compounds identical with natural bodies. . . . In the case of free nitrogen the combination with either or all of these elements is less easy, because we encounter in it a greater natural lack of affinity, and general inertness under all ordinary conditions of temperature and pressure. In order to surmount the difficulties, we must fulfil certain necessary thermal, chemical, and mechanical conditions. When these have been definitely established and complied with, we may expect that the most marvelous developments will immediately follow, because nitrogen is at once the most costly and the most essential component of all organized life.

"All organic bodies can be made to part with their nitrogen in the form of ammonia. Why cannot we, therefore, with cheap and plentiful ammonia as the starting point, build up artificially and rapidly many substances of incalculable value, which are in constant demand for the purposes of industry, and for the supply of which we are now entirely dependent on the diminishing reserves of nature and its slow processes of renewal? The question is not a hasty one, nor is there anything impossible or improbable in the hypothesis."

The numerous compounds now produced by laboratory methods into which nitrogen enters, though of great importance and value, are insignificant when we consider "two other important fields which would be benefited beyond the bounds of calculation by the cheap production of cyanids and ammonia from atmospheric nitrogen. The first and most interesting to mining engineers and metallurgists is in the treatment, by the cyanid process, of those lean ores containing gold and silver, which at the present time abound, and which yet have no commercial value. The second and most interesting to agriculturists is in the restoration to the soil, at a comparatively nominal cost, of the nitrogenous element of fertilization which is yearly removed by the crops, and the actual loss of which has been estimated by Professor Alvord at $720,000,000 for this country alone. There is, then, a boundless demand for nitrogen which can never be satisfied from any source now known to us. It is true that there is an abundance of nitrates in Chile and Peru, but they are far too costly for general use; and, as to ammonia, it is naturally too expensive, the whole of our present supply being derived from a small percentage of the total nitrogen contained in coals either in the manufacture of coal gas, or from the gases of the coke oven and the blast furnace. As to cyanids, we derive our supply from yellow prussiate of potash, and this is still made almost exclusively in the old-fashioned way by the fusion of such valuable organic matter as dessicated blood or horn with carbonate of potash and iron filings. In the face of these facts, and in view of the fascinating nature of the subject, I might well be excused for entering into minute details concerning the fixation of atmospheric nitrogen, but the chemical literature of the past few years is so pregnant with records of experiments and failures that I shall content myself with a very brief retrospective glance."

The article then rapidly passes over the course of experiments directed to the fixation of nitrogen, ranging from those of Bunsen and Playfair in 1845, to 1893, when Fogarty perceived the reason of former failures and struck out a new path. Dr. Wyatt says the processes all failed "because they made no allowance for the most essential condition attendant upon the combination of carbon with nitrogen,"—to wit, "that one of the elements should be nascent, and endowed with the chemical energy pertaining to the nascent state." Fogarty's process is thought to be full of promise. "The latter now uses no fixed carbon for any other purpose than the manufacture of a highly superheated producer gas consisting chiefly of oxids of carbon, free hydrogen, and nitrogen." He passes this gas into and through a suitable retort, and simultaneously drives in with it in the same direction a measured volume of hydrocarbon vapor derived from burning fuel oil. The mixed gases come in contact with a measured quantity of incandescent and finely-comminuted lime, which showers down from the top of the retort. His gas at this stage contains no free oxygen or carbonic acid, and the hydrocarbons are, therefore, ultimately decomposed into acetylene, free carbon, and hydrogen, all of which may combine with nitrogen and the lime to produce calcium cyanid and subsequently ammonia and fuel gas."

Passing Dr. Wyatt's explanation of the reactions which take place in the Fogarty furnace, as too technical for other than chemical readers, we will close this review with the following statement, which, coming from such an authoritative source, has almost the force of a prediction.

"The question being satisfactorily disposed of in this manner, I believe that the thermal and chemical conditions required by the new Fogarty process are well established. The remaining condition involves the construction and arrangement of certain mechanical details connected with the new furnace which is now about to be erected, and of these I do not feel competent to speak with authority. If the difficulties in this direction are successfully overcome, as it is claimed they easily can be, the production of cheap cyanids and ammonia from the fixation of atmospheric nitrogen will at once be placed upon an industrial and commercial basis, and chemistry will bind and place at our feet the hitherto least tractable of nature's elements."

Electrical Measurement of Starlight.

A NEW method of measuring the light of the stars, very much more rapid than the previously-existing method,—action on a photographic plate,—is described in *Nature*. The principle of the new method is the difference of potential produced by lights of different intensities in a photoelectric cell. "Such a cell is constructed with selenium, aluminum, and liquid œanthol. If we take a strip of clean aluminum,—say ½ in. long, $\frac{1}{10}$ in. wide, and thick enough to be fairly stiff,—lay it on an iron plate which is heated by a Bunsen flame, and place on the end of the strip a very small particle of selenium, this selenium will melt and form a small black globule of liquid. Let the flame be now withdrawn, and the globule of melted selenum spread over the end of the aluminum strip by means of a hot glass rod, so that it forms a thin uniform layer of area $\frac{1}{10}$ in. square on the end of the strip, and let this dark layer cool to about 217° C., or a few degrees below its melting point. Now apply heat again to the upper surface of the iron plate until the aluminum strip becomes nearly hot enough to remelt the layer of selenium. In this process the color of the layer will gradually change from black to a greyish brown. When it is just on the point of melting, withdraw the heat and blow over its surface; this will instantly check the tendency to melt, and will leave the surface of the selenium in the state in which it is most sensitive to light. If this strip (or rather its selenium-covered end) is immersed in a glass tube containing acetone or œnanthol, and connected with one pole of a quadrant electrometer, whose other pole is connected with a platinum wire sealed into the glass tube, we have a photo-electric cell, in which the action of light falling on the selenium layer results in giving the selenium a positive electric charge and the liquid a negative one, the former charge being conveyed to one pole of the electrometer by the aluminum plate, and the latter to the other pole by the platinum wire sealed into the cell.

"Roughly speaking, the difference of potential produced in such a cell as this by ordinary diffused daylight is something between one-third and one-half of a volt."

About the first of the year 1894 Mr. Geo. S. Minchin, the author of the article reviewed, made an important improvement in the photo-electric cell. This improved cell remains constant about 3 weeks, whereas the earlier cells began to deteriorate in about 6 hours. The conversion of light into electromotive force, as exemplified by this cell, is exceedingly interesting.

"In the figure *C C* is a cork in which the glass tube, *B*, containing the aluminum wire at the end *A*, and the attached platinum wire, fits, this cork fitting tightly into the side of the glass cell which contains the liquid. The tube, *B*, passes close up to a quartz window, *Q Q*, cemented to the cell opposite the cork, *C C*. The light of the star is received on the window, *Q Q*, and is made to fall on the selenium layer at the end, *A*, of the tube, *B*. A platinum wire, *P*, is sealed into the bottom of the glass cell, and conveys the charge taken by the liquid to one pole of the electrometer, while the platinum wire, *P*, conveys the charge taken by the selenium to the other pole of the electrometer; *S* is a ground stopper at the top of the cell, where the liquid is poured in.

"This cell is fitted into a holder which can be fixed to a telescope in place of the eye-piece; and this cell-holder allows of the adjustments which are necessary to bring the point, *A*, to the position of the image of a star."

With this instrument Mr. Minchin, assisted by Professor Fitzgerald and Mr. Wilson, measured the electric-motive force of "Jupiter, Saturn, Vega, Arcturus, Regulus, Procyon, and some other stars last April, in Mr. Wilson's observatory at Daramona, Westmeath. The telescope used was Mr. Wilson's 2-ft. reflector." The extreme sensitiveness of the cell to light, Mr. Minchin says, is such that an ordinary paraffine candle held at a distance of 9 ft. from the window, *Q Q*, produces an electromotive force of about 0.03. The light of Vega concentrated in the 2-ft. telescope produces a little more deflection in the electrometer than the candle does. The electromotive force of Arcturus was 82 per cent. of that produced by the candle; that of Saturn 56 per cent. A comparison of the results obtained by this method and those of the photometric method is made, in the course of which it is shown that agreement between these results is not to be expected when two stars of different colors are compared.

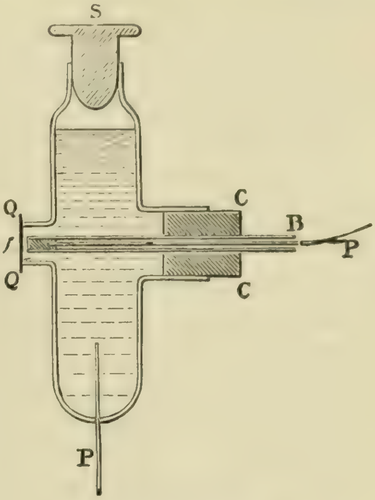


PHOTO-ELECTRIC CELL.

The Maxim Flying Machine.

THE status of this celebrated undertaktaking in July of the present year is described by A. G. Greenhill in *Nature* (Aug. 1). On July 5 a large party of scientific men visited Baldwin's Park, Bexley, England, by invitation of Mr. Maxim, and were treated to an exhibition of the machine and tests of its lifting and sustaining capacity. "The invitations were carefully distributed among those who were competent to judge of the magnitude of the task to be attempted, and who were prepared to examine closely the ingenious mechanical details by which it was clearly demonstrated that the machine had ample power to lift itself off the ground, carrying with it a supply of fuel and water and a crew for the navigation.

"The Bexley machine is purposely designed of extreme size with the intention of thoroughly testing and elaborating the details of mechanism, and of measuring the lifting power within immediate reach of a workshop and skilled mechanics, more than of actually taking to the air; this will probably be first attempted with a much smaller machine, capable of lifting one man, of jockey-like proportion and mounted on a boat on a lake, so that short flights, like those of a flying-fish, can be attempted for initial practice.

"The lifting force of the machine is measured automatically as it runs along a railway track about ½ mile in length, and the machine is prevented from taking to flight by wheels running underneath outer wooden rails. Much yet remains to be done in the way of practice in vertical steering before taking leave of the earth, the chief difficulties of the aviator beginning when he wishes to descend and alight on the ground again."

"The machine, complete, with water, naphtha fuel, and crew of three men on board, weighs 8000 lbs." With a pressure of 275 lbs. of steam per square inch, the engines develop 360 h. p. The thrust of the screws is 2000 lbs., and the lifting effect of the aeroplanes and wings (4000 sq. ft. area) is 10,000 lbs. A thrust of 2000 pounds at 45 miles an hour gives 240-thrust horse-power; or, with a speed of advance of the screw of 60 miles an hour, 320 indicated horse-power.

"The total projected disc area of the screws is 500 sq. ft., each screw being nearly 18 ft. in diameter, with a pitch of 16 ft., thus requiring three hundred and thirty revolutions a minute to give a speed of advance of 60 miles an hour.

"Mr. Maxim calculates that, after making all allowances, he can at present lift 28 lbs. per horse-power; but that, with improvements, he hopes to raise this figure to 50 or 60 lbs., and then a machine could take a flight of 500 or 600 miles.

"When the machine is perfected, Mr. Maxim claims that the railway may be dispensed with, and that a short run over a moderately level field will enable it to attain the velocity necessary to rise. As far as landing is concerned, he says that the aerial navigator will touch the ground while moving forward, and the machine will be brought to rest by sliding on the ground for a short distance. In this manner very little shock should result, whereas, if the machine is stopped in the air and allowed to fall directly to the earth without advancing, the shock, though not strong enough to be dangerous (?) to life or limb, might be sufficient to disarrange or injure the machinery."

Of course this implies a tract of land of sufficient size, and having surface of a proper character, to permit a safe landing. If the machine be employed for regular traffic, as river steamboats are, such landings could be provided. But it has generally been supposed that Mr. Maxim's aim was to produce a machine applicable to military service, and landings of the kind considered are not portable. From a military point of view the lives of the crew might not be important, after enough skilled navigators of flying machines have been trained to the art; but the crippling of the machine might be attended with serious derangement of plans, and other bad consequences, not to mention the item of cost, which would not be trifling. The problem of artificial flight cannot be considered as fully solved till machines are constructed that can come down easily and safely upon any handy bit of level ground, as pigeons alight upon wheat fields.

"The aeroplanes and wings are mounted on a slope of about 1 in 8. These surfaces are formed of canvas, stretched on a skeleton frame-work of hollow steel rods for the struts, and thin steel for the ties; the large central æroplane is composed of two parallel canvas surfaces, with a space between, and in this way the shape is preserved better; and the general set of the wings, smooth, like cardboard should excite the envy and stimulate the imitation of our sailmakers for yacht racing. The front and rear wings are pivoted about a horizontal axis, so as to act as rudders in a vertical plane."

The machine is started from a position in which it has been retained by being tied to an indicator post; "the propellers are then set in motion, and soon drive gales of wind in their wake. When the pull of the rope has reached a definite amount,—say 2000 lbs.,—a hook is released, and the machine starts on its journey along the track. Dynamometers register simultaneously the thrust of propellers, so that much interesting information concerning the dynamics of propulsion can be obtained here, especially if Mr. Maxim will stretch a wire carrying ribbons across the axes of the propellers, in front and in rear, to measure the direction of the air currents. The speed Mr. Maxim deals with is about double the speed of the torpedo boat in water; but the effect of 'cavitation' in water, which is beginning to trouble the naval architects, is one which will not concern the propeller working in air. Now that the main mechanical difficulties of construction have been overcome, a longer track is required for the purpose of practice in vertical steering while the machine is off the ground but bearing upwards against the outer rails. It is unfortunate that difficulties should have been thrown in the way of making an extension of the present track beyond the domain of Baldwin's Park; so another practice ground, perhaps a sheet of water, must be found, not too far from headquarters or from skilled assistance."

Contamination of Ice.

It used to be thought that ice purified itself in freezing. When impure water freezes very slowly, and remains, while freezing, in a large mass, perfectly still, some parts of the ice will be found to have nearly or quite freed themselves from mechanically-suspended impurities and even of dissolved matters; but this action is rarely uniform throughout the mass, and it is still more rare that the perfect quiescence, essential to such a result, is met with in natural bodies of water relied upon as a source of ice supply.

The Engineering Record (Aug. 10) editorially declares that the notion that ice is generally pure must be abandoned, and adds that "engineers have long called attention to the dangers to public health which are invariably created when ice is taken from bodies of water carrying dangerous pollution." This would seem to imply that the knowledge of the fact stated has been diffused for a greater period than is really the case. We do not remember anything of an authoritative character on this subject printed earlier than 1880, about which time comparisons between the purity of machine-made ice and natural ice were made, and the subject of impurities in natural ice began to attract serious attention.

The Engineering Record is, however, probably right in the supposition that a recent Chicago ordinance is the first prominent example of municipal legislation limiting the amount of impurity in ice offered for sale to citizens. We can recall no other instance; but the example is a good one, and will doubtless be followed in other cities.

"In April last there was passed by the council of the city of Chicago, and approved by the mayor, an ordinance setting forth certain provisions in regard to the pollution of ice supplied by the local ice companies of that city, among which are found the limitations of 0.009 part per 100,000 for free ammonia and 0.09 part per 1000 for albuminoid ammonia, together with one or two others of a similar character, and one requiring that no ice shall be 'cut or taken from any river within 3 miles of any town or city of over twenty thousand inhabitants, or cut or taken from any lake, pond, hole, or excavation' which has been subject to contaminations described in the act.

"Probably no sanitary authority will criticise the preceding limits as being too severe or unnecessarily low for the safety of the public health. It is well known, of course, that the degree of danger arising from the pollution of either water or ice is to some extent inferential when it is based solely on chemical analysis; but the latter is essential, and it is difficult to see how higher limits could properly be permitted in a municipal ordinance. The same act also contains a provision forbidding the selling or keeping for sale of any ice containing pathogenic bacteria. The ice companies object, perhaps not unnaturally, to a rigorous enforcement of such an ordinance, and the matter has attracted considerable attention in the city of Chicago from many parties interested on both sides of the question. A large amount of ice is taken from waters within the limits of the city, and a number of chemical analyses which have been made of such ice appear to indicate an excessive pollution, although it is still an unsettled matter just what portion of the ice offered in Chicago is sufficiently free from contamination to raise its character above question."

The ice supply for New York city is largely derived from the Hudson river, and much of it is harvested at short distances below towns situated upon the banks of the river. Usually the ice is formed rapidly during periods of severe cold, and therefore is made under conditions favorable to retention of impurities. Many of the impurities in ice are chemically produced and held in solution; but bodies of filth are often suspended in the ice, and some of them are disgusting to contemplate in an article of common dietetic use. The germs of bacteria are, however, the most dangerous when they are present in ice.

The concluding remark in this editorial is worth heeding. "It is to very little purpose to secure a pure and uncontaminated public water supply while its users melt ice in it containing bacteria characteristic of many acute diseases, as well as other forms of pollution which induce physical conditions inviting attacks of disease. The special line of contamination is a source of no little danger to the public health, and it will eventually be found that the origins of all our ice supplies will have to be guarded from pollutions of any kind with precisely the same kind of care which is exercised in regard to sources of potable water, or else dependence will have to be placed upon the artificial production of ice from distilled water. Either method is feasible, as experience has already shown, and it will be impossible to reach a reasonable sanitary condition in respect to ice consumption until healthful ice is supplied to the public by one or the other of them."

Frauds in Textile Goods.

A WRITER who signs himself "Randolph" in *Boston Journal of Commerce* makes an exposure of several fraudulent practices, of which purchasers of textile goods ought to be made aware. He asserts that "at the present time there is scarcely any class of industrial production" in which these practices do not prevail. "The finisher of cotton and wool goods has come to feel the effects of these practices, and it results that he often is called upon to be an accomplice in them."

"Randolph," who may have special reasons for adopting a *nom de plume*, evidently speaks from the book; but he deals particularly with only that class of adulteration by which the specific weights of textiles are fraudulently increased. By some of these methods the weights of fabrics may be increased from 3 to 4 ounces per yard, and these practices have become so systematic that a market has been found for special machines used in "weighting" cloths. Woollens, cottons, and silks are "weighted."

"Two substances may be mentioned as being used for this purpose; one is silicate of soda, and another is a mixture of barium chlorid and Glauber's salt. In the latter case the two substances are dissolved in water separately, then mixed together, and a sediment is formed which is used for the purpose desired. Before this sediment forms, the liquid is comparatively clear, and is of the nature of common salt. Now, when the goods are subjected to this solution, the fibers are more or less encrusted in this precipitate, which adds greatly to the weight. The weight is brought about, not only by adding the substance itself, but from the fact that it enables the fiber to absorb and hold a large portion of moisture. Common salt in itself has this effect. In the first place, if it can be so manipulated as to form an unnoticeable deposit in the fibers of the cloth, it increases the weight in two different ways. One way is by its own inherent weight; the goods will weigh just as much heavier than they should by the amount of salt used. But another way which this adds to the weight lies in the fact that the salt absorbs moisture, and this added weight of moisture which the fibers are enabled to carry serves to increase the weight of the goods to a very considerable extent."

An increase of one-tenth of the weight may be given to the raw fiber before spinning by the use of a mixture of fuller's earth and a solution of soda; this unites with the oil to form an insoluble soap diffused over the fiber, which also attracts moisture, thus increasing the weight.

"In the finishing of woollen fabrics some of the agents which are employed, such as glue, starch, gelatine, albumen, and silicate of soda, are often attended with some kinds of good results, but at the same time, if they are not correctly handled and carefully employed, they must certainly bring about this fraudulent increase in weight, which every careful finisher should try hard to avoid. For really adding to the weight of the goods in the finishing department, china clay and a solution of carbon and wax are often employed.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Technical Journals—See Introductory.

*692. The Canadian Lumber Industry. Ill. J. S. Robertson (Its importance, vast extent and development). Eng Mag–Oct. 3500 w.

708. Fraudulent Weights. Randolph (Materials added to cotton and woolen textures to increase weight). Bos Jour Com–Aug. 10. 1200 w.

*709. The Maxim Flying Machine Ill. A. G. Greenhill (A visit paid to the machine, with description). Nature–Aug. 1. 2000 w.

728. The Contamination of Ice (Ice harvested from rivers and lakes may contain dangerous impurities. Editorial). Eng Rec–Aug 10. 700 w.

744. The Fixation of Atmospheric Nitrogen and the Manufacture of Cyanides and Ammonia. Francis Wyatt (Laboratory methods theoretically considered). Eng & Min Jour–Aug. 10. 2800 w.

750. Commercial Products Resulting from Acetylene. A New Use for the Electric Furnace. R. R. Duncan (We may expect to see the influence of acetylene ramifying throughout all organic chemistry). Elec Eng–Aug. 14. 700 w.

768.—75 cts. Composition of the Sulphur Petroleums of Ohio and Canada. Charles F. Mabery (Chemical analysis and its importance). Tech Quar–April. 6800 w.

770.—75 cts. Further Experiments for Determining the Feasibility of Fire-Clays. Ill. H. O. Hofman. Tech Quar–April. 3300 w.

†785. The Spectroscope in Recent Chemistry. R. A. Gregory (What it reveals bearing upon the alleged identity of the element helium, obtained from cleveite, and the substance represented by the helium line in the solar spectrum). Fortnightly Rev–Aug. 5000 w.

†786. Professor Huxley. I. Some Personal Characteristics. G. C. Brodrick. II. As Anthropologist. E. B. Tylor. III. As Biologist. A Student of Science. IV. As Philosopher. W. L. Courtney. Fortnightly Rev–Aug. 6500 w.

789. Photographic Printing by Machinery. Ill. (Descriptive). Sci Am–Aug 17. 1600 w.

790. Experimental Psychology. E. B. Titchener (Methods of work explained). Sci Am Sup–Aug. 17. 5500 w.

792. The Disposition of the Louisiana Molasses Crop. W. C. Stubbs (A paper read before the La. Sugar Planters' Asso. and printed in La. Planter). Sci Am Sup–Aug. 17. 3800 w.

793. Cheap Ocean Transportation. Ill. The Robertson cigar-shaped raft, for the transportation of lumber). Min & Sci Pr–Aug. 10. 1500 w.

*814. The Scotch Shale-Oil Industry. (Descriptive). Engng–Aug. 9. 800 w.

*817. Military and Civil Works in India. Emeritus (A popular description portraying peculiarities of population, effects of public works, wages and other interesting particulars). Engng–Aug. 9. 5000 w.

*819. A Chief Use of Sanitary Congresses. Editorial (The chief use of these congresses is considered to be the education of the public at large in matters pertaining to sanitary science and engineering). San Rec–Aug. 9. 800 w.

826. Training Our Firemen (Account of the drill exercises at the New York training school). Fire & Water–Aug. 17. 600 w.

834. Richard M. Hunt (Sketch taken from the N. Y. Tribune). Am Arch–Aug. 17. 1300 w.

*843. A German Ironmonger's Business (Descriptive). Irm–Aug. 10. 1900 w.

*847. The Eruption of Vesuvius, July 3. 1895. Ill. H. J. Johnston-Lavis (Descriptive). Nature–Aug. 8. 1700 w.

*859. The Transport of Petroleum (Editorial review of improvement of transport facilities). Eng, Lond–Aug. 9. 2500 w.

890. Respiration, Suffocation and Resuscitation. J. Mount Bleyer (The main physiological factors which play the rôle in respiration, suffocation and resuscitation, and the author's method of pneumatic artificial respiration). Elec Rev–Aug. 21. Serial. 1st part. 2500 w.

908. Manufacture of Glue and Sizing. Ill. (Description of processes and appliances). Sci Am–Aug. 24. 1000 w.

*936. The Meerschaum Mines of Anatolia (Interesting general description). Jour Soc of Arts–Aug. 16. 500 w.

*941. Unsanitary Schools and Public Indifference. Douglas H. Stewart (A comprehensive criticism of the neglect of proper sanitary methods in the schools of New York City, which by extension can be made to arraign similar neglect in the majority of the schools in the cities and towns of the United States). Forum–Sept. 4400 w.

*942. Methods and Difficulties of Child-Study. Mrs. Annie Howes Barus (An examination into the utility of a close study of child-life as bearing upon progress in the sciences of psychology, pedagogy and anthropology). Forum–Sept. 3800 w.

952. The Production of Cyanides. H. N. Warren (Method of production and salts used). Am Mfr & Ir Wld–Aug. 23. 400 w.

*959 The Resources and Industries of Birmingham (An interesting account of the various industries and commerce of the great city —written in popular style). Ir & Coal Tr Rev–Aug. 16. 10,000 w.

967. Working Petroleum in Lower Alsace (Methods and appliances. The Alsace petroleum industry dates back to 1742). Am Gas Lgt Jour–Aug. 26. 1400 w.

*973. The Arts and Industries of Venice P. Molmenti (Written in popular style and describing some industries for which Venice has long been famous). Chau–Sept. 4000 w.

983. The Curve of Least Resistance in Water and in Air. Meety Moulton (Results of experiments on ice in water, and wax in hot air). Ry Rev–Aug. 24. 500 w.

984. Interstitial Space (Experiments made to determine the space between particles of emery). Ry Rev–Aug. 24. 1200 w.

986. The Relationships and Responsibilities of Museums. G. Brown Goode (The object of the paper is to begin the codification of the accepted principles of museum administration; and to set forth the aims and ambitions of modern museum practice). Sci–Aug. 23. 6500 w.

987. The Processes of Life Revealed by the Microscope. A Plea for Physiological Histology. Simon Henry Gage. Sci–Aug. 23. 6000 w.

*998 Weather Fallacies (An address to the Royal Meteorological Society by Wm. Richard Inwards). Nature–Aug. 15. 6400 w.

†1030. The Relations of the Diurnal Rise and Fall of the Wind in the United States. Frank Waldo. Am Jour of Sci–Sept. 1600 w.

1037. Fascination by Snakes. Harold S. Ferguson (The author concludes that the snake does not hypnotize, but that the subject is self-mesmerized). Sci Am–Aug. 31. 1000 w.

1049. The Splash of a Drop and Allied Phenomena. Ill. A. M. Worthington (Abstract from a paper read before the Royal Inst. Examples of the successive forms of splashes as revealed by instantaneous photographs). Sci Am Sup–Aug. 31. 2700 w.

†1072. Trades and Faces. Dr. Louis Robinson in Blackwood's Magazine (Discussion and general principles). Pop Sci M–Sept. 7500 w.

†1073. Natural Rain-Makers. Ill. Alexander McAdie (The efficiency of clouds, etc). Pop Sci M–Sept. 2000 w.

†1074. Only a Match. C. Falkenhorst (Historical; interesting). Pop Sci M–Sept. 3000 w.

*1133. A Scheme of Color Standards. J. H. Pillsbury (Identification of colors by their wave lengths, together with an analysis of a number of colors). Nature–Aug. 22. 4800 w.

*1134. Evidence of the Twilight Arc upon the Planet Mars (Calculations and results in measuring the diameters of Mars). Percival Lowell. Nature–Aug. 22. 4800 w.

†1143. Rainfall and Typhoid Fever. William P. Mason (A paper bringing out the relation, along with statistics, especially in Michigan). Jour Fr Inst–Sept. 1900 w.

*1151. Elasticity of the Wing (Action of a bird's wing on air with relation to flying machines). Am Eng & R R Jour–Sept. 1200 w.

*1152. A Lilienthal Flying Machine. Ill. (A dimensioned drawing with two views of the machine, and results of experiments leading to its development). Am Eng & R R Jour–Sept. 200 w.

*1167. Coffee Growing in Peru (Descriptive). From the South American Journal. Bd of Tr Journal–Aug. 1000 w.

*1178. The Value of Weather Forecasts to Agriculture and Inland Commerce. Mark W. Harrington (The requirements, difficulties and needs; the benefits of the forecasts to various industries). Rev of Rev–Sept. 2200 w.

1193. The Clay Industry of the United States (From the statistics in the report of the Geological Survey). Arch & Build–Aug. 31. 2700 w.

†1221. Cements (Remarks upon various adhesive cements). Ind & East Eng–Aug. 3. 1100 w.

1262. The New Incandescent Light (A competitor to the Welsbach Incandescent Gas Lamp). Am Mfr & Ir Wld–Sept. 6. 300 w.

1269. The Future Supply of India-Rubber (Editorial. Adversely discusses the advisability of the systematic planting of rubber trees). Engng–Aug. 30. 1100 w.

1286. The Relations of the Industries to the Advancement of Chemical Science. William McMurtrie (An address before the Am. Asso. for the Adv. of Science). Science–Sept. 6. 8000 w.

COMMENT & CRITICISM

The Engineering Magazine Index.

I enclose P. O. Order for my subscription to your Magazine.

In this day of exuberant literary production there is felt to be an ever-growing need of such a publication. So much is being written on every subject, and it is so scattered, that it is impossible to keep one's self posted on the literature even of one's special subjects, except with the help of just such a systematic guide as is furnished by your Magazine Index. Might I suggest something, however? Suppose the technical index matter to be printed on thin paper and on one side only. Then those keeping card catalogues could extract the pages, gum the blank sides, let them dry, cut up with scissors, and, by damping, mount each item on a card which would thus fit in with other references, already accumulated, and would also have the advantage of enabling each one to classify and select according to his special needs, and also to alter his classification as his needs changed.

With all good wishes for the continued success of your useful Magazine.

ELFRIC DREW INGALL.

Office Geological Survey, Ottawa, Canada, Sept., 1895.

[Mr. Ingall's suggestion is a very proper one. There can be no doubt that a considerable number of persons in the habit of keeping card indexes would be greatly benefited by the publication of our index in the form which he indicates. From the standpoint of a publisher, however, the idea is impracticable, because of the limited number of persons who would pay for such a publication. It has been estimated by those who are competent to judge, that it would be almost impossible to secure more than one hundred regular subscribers for a publication of this kind. The number of persons who keep card indexes is very limited; very few of them are kept upon the same system; and among those who keep them very few would be influenced to subscribe to a publication by reason of the fact that it would be used as Mr. Ingall suggests. In short, it is a most excellent idea for a few who could make such good use of it, but the publication in that form is impracticable because of the enormous cost in excess of any possible income from it.—THE EDITOR.]

An Error Corrected.

Is there not an error in 9th line from bottom of p. 683 of your July issue? "100,000 men, who receive $1,500,000 per year"—I did not read the article carefully but this statement caught my eye while glancing through it, and in hurriedly examining other statistics they failed to harmonize. G. D. COLTON.

Collinsville, Conn., Aug., 1895.

There is a manifest error in the figures mentioned by Mr. Colton in my article of July. It should read: "To do this rebuilding and repairing requires 100,000 men who receive $50,000,000 per year and though generally, etc." The census of 1894 gives the number of men and women employed at 110,619, and the wages paid as $63,232,052 which would seem to verify my figures fairly well.

I am glad to be corrected by Mr. Colton, but the error is very evident, as it gives an average wage to each man of but five cents per day of 300 days to the year.

Very truly yours,

JOHN C. WAIT.

Norwich, N. Y., Aug., 1895.

Topical Index. Wood Stave Pipe.

I NOTE that you republish in Aug. number my letter referring to Index of Hydraulic Engineering.

Permit me to say that the topical index mentioned has been through a revision, and now covers 72 pp. of type-written foolscap; large additions have also been made to the card index.

I can corroborate the testimony on page 1003, August number, as to use of Wood Stave Pipe. It has been used here by the Collins Co. for 40 years or more, in sizes up to 5 or 6 ft. dia. for conducting water to turbine wheels. G. D. COLTON.

Collinsville, Conn., Aug., 1895.

Plans for Home Grounds.

In the August number of The Engineering Magazine, in the department of *Domestic Engineering*, I notice an interesting article on "Plans for Home Grounds." To my mind the difficulty in perfecting such plans lies not so much with the plan itself as with the place selected for its execution. You assuredly cannot have a fine lawn, good scenery, and woods where these things do not exist, even in a primitive state. Extensive travel has shown me that the best places to build homes, with a view to good grounds about them, is, in most of the states, about the great lakes, at least in Wisconsin, Michigan, Indiana, and northwestern New York. In the west, I think Iowa is first as regards this matter, but the hills mar, in some regions—especially in central Iowa—what would otherwise be ideal places for home and grounds. T. P. C.

Council Bluffs, Iowa, Sept. 1, 1895.

Mining Under the Sea.

In addition to the cases of mining under the sea referred to in The Engineering Magazine for June, there is one at Lota and Coronel on the coast of Chili. There the sea is shallow and the coal does not lie deep. The shafts are on shore, and the coal is lightered out to vessels.

A few years ago a valuable property in the bay of Coronel was ruined by working too near the surface, contrary to the advice of men whose judgment should have been respected. Fortunately the men were not in the mine when the sea broke in—with such force that the roar of the rushing water was heard miles away.

O. F. WHITFORD.

Buffalo, Sept., 1895.

[Besides the project for mining coal under Sydney harbor, N. S. W., above referred to, and the Chilian case cited by our correspondent, several other examples of mining under water might be quoted, as some of the Cornish tin and copper mines, English coal mines, the Silver Islet silver mine in Lake Superior (the most remarkable of all), and the explorations for iron ore under Lake Angeline, Michigan. Grappling for iron ore in Scandinavian lakes, dredging for gold under the sea and in river beds, and dredging for phosphates in South Carolina are also somewhat related cases.—Editor.]

Heating Feed Water for Marine Boilers.

Nearly two years ago I read in The Engineering Magazine that there was a great need of a device for heating feed water for marine boilers. I investigated and found that marine boiler builders very much desired something for that purpose. I devised a system for taking water from the bottom of a boiler, heating it, and delivering it back to the boiler with the feed water. On consulting with a marine engineer of large experience, he said that a boiler should be strong enough to withstand strains without injury, and the colder the bottom of the boiler the better for the ship's timbers. I agreed with him and dropped the matter. *The Railway Master Mechanic*, for July, published extracts from the reports of committees and the discussions at the R. W. M. M. convention, which developed the fact that there was trouble from bulged fire box sheets and a great diversity of opinion as to the cause. It soon occurred to me that I had scalded my hands as a result of this condition, when searching for something else.

When water containing lime, magnesia, soda, &c., has been used some time in a boiler for making steam (unless the boiler be blown down and replenished often), it accumulates salts in solution, elevating the boiling temperature. If some of this wa- is heated to boiling in a glass flask and water added there will be a flash of steam.

Why water holding a large amount of salts in solution should suddenly evaporate to steam a part of the feed water instead of the feed water instantly reducing the temperature of the water to which it is added I cannot say, but *it does*, and the only sure remedy is hot feed water.

F. A. BUNNELL.

Syracuse, N. Y., Aug., 1895.

BOOKS RECEIVED.

More than Two Thousand Questions Relating to Steam Engineering which every Engineer Should be able to Answer; Systematically Arranged for the Practical Tradesman to Facilitate the Acquiring of Knowledge Needed by Giving Chance for Self-Study; with Argued Answers and over 500 Illustrations. By E. Spangenberg, C. E. Volume I. Laborers' Instruction Publication Co., St. Louis, Mo., 1895. (192 pp., 3"¼×4¾". Cloth, price 75 cts.")

Arithmetic and Algebra, Plain and Solid Geometry Explained to the Practical Tradesman. By E. Spangenberg, C. E. Volume I. Laborers' Instruction Publication Co., St. Louis, Mo., 1895. (197 pp, 3¼"×4¾". Cloth, price, 75 cts.)

Eighth Annual Report of the Board of Public Works, City of Duluth, Minn., for the year ending Feb. 28th, 1895. Press of J. J. Le Tournean & Co., Duluth, Minn. (Pamphlet, 57 pp, 6"×9".)

Michigan Mining School, Houghton, Mich. Prospectus of Elective Studies, May, 1895. Published by the Mining School, Houghton, Mich. (Pamphlet, 50 pp., 5"×7¾".)

Brick Pavements. By W. W. Wallace, Jr., Willoughby, Ohio. (61 pp., 4" × 6". Cloth, price, 50 cts.)

Ninth Biennial Report of the Board of Directors of the Kansas State Historical Society, for the period commencing Nov. 16th, 1892, and ending Nov. 20th, 1894. Also Proceedings of the Meeting, 1895. Topeka Press of the Hamilton Printing Co., 1895. (Pamphlet, 174 pp, 6"×9".)

Bulletin No. 2, United States Department of Agriculture, Section of Foreign Markets, under the immediate supervision of the Secretary of Agriculture. The World's Markets for American Products. The German Empire. Washington Government Printing Office, 1895. (Pamphlet, 91 pp., 6"×9".)

City of Boston, Department of Parks. Twentieth Annual Report of the Board of Commissioners for the year ending Jan. 31st, 1895. Printed for the Department, 1895. (Pamphlet, 119 pp., 6"×9".)

Bridge Deflections. By Malverd A. Howe, Member of the Engineers' Club of St. Louis. Read May 15th, 1895, and reprinted from the Journal of the Association of Engineering Societies, Vol. XIII, No. 6, June, 1895. (Pamphlet, 20 pp., 6" × 9".)

Annual Report of the City Engineer of the city of Providence for the year 1894. The Providence Press, 1895. (Pamphlet, 91 pp., 6" × 9" with a number of folding insets.)

Atlantic Crosswise Canal Across New Jersey. Report of the canal commissioner of Philadelphia as transmitted to the select and common councils of the city of Philadelphia in accordance with the provisions of city ordinance, Approved July 2d, 1894-1895. (Pamphlet, 54 pp., 9" × 6".)

Bulletin No. 3, United States Department of Agriculture, Section of Foreign Markets (under the immediate supervision of the secretary of Agriculture). The World's Markets for American Products. France. Washington Government Printing Office. Pamphlet, 74 pp., 6" × 9".)

Sanitary Engineering. By William Paul Gerhard, C. E., Consulting engineer for sanitary works, member American Public Health Association, etc., etc. Reprinted from the Journal of the Franklin Institute, July-August, 1895. Philadelphia, 1895. (Pamphlet, 48 pp, 6" × 9".)

The Work of the Sanitary Engineer in Time of Epidemics, in Time of War, and in Sudden Calamities in Civic Life. By William Paul Gerhard, C. E., Consulting engineer for sanitary Works, Member American Public Health Association, etc., etc. Reprinted from the Sanitarium for June, 1895. New York: Burr Printing House, 18 Jacob Street, 1895. (Pamphlet, 14 pp., 6" × 9".)

Annual Report of the Commissioner of Civil Works for the Year 1894. Made to the common council of the city of Brooklyn, Feb. 1st, 1895. (283 pp., 6" × 9".)

Annual Report of the City Engineer of Toronto for 1894. Toronto: The Carswell Co., Ltd., City Printers, 1895. (Pamphlet, 174 pp., 7" × 10".)

Department of the Interior—United States Geological Survey. Charles G. Walcott, Director. The Stone Industry in 1894. By William C. Day. Extracts from the 16th Annual Report of the Director, 1894-1895. Part IV—Mineral Resources of the United States. Calendar Year 1894. Washington Government Printing Office, 1895. (Pamphlet, 83 pp., 7¾" × 11½".)

Department of the Interior—United States Geological Survey. Charles G. Walcott, Director. The Production of Tin in Various Parts of the World. By Charles M. Rolker. Extracts from the 16th. annual report of the director, 1894-1895. Part III—Mineral Resources of the United States. Calendar Year 1894. Washington Government Printing Office, 1895. (Pamphlet, 88 pp., 7¾"×11½".)

14th Annual Report of the United States Geological Survey to the Secretary of the Interior, 1892-1893. By J. W. Powell, Director. Part I, Report of the Director. (321 pp., 7¾"× 11½".) Part II, Accompanying Papers. (Cloth, 597 pp., 7¾"×11½", with pocket inside cover containing three maps, 18"×28".)

Department of the Interior. Census Office. Robert T. Porter, Superintendent; Carroll B.

Wright, commissioner of labor in charge. Report on Population of the United States at the 11th Census, 1890. Part I. Washington, D. C. Government Printing Office, 1895. (Cloth, 968 pp., 9"×11½".)

Department of the Interior. Monographs of the United States Geological Survey. Volume XIII. Raphael Pumpelly, J. E. Wolff, and T. Nelson Dale. Geology of the Green Mountains in Massachusetts. (Cloth, 206 pp., 9"×11½".) Volume XIV. Robert Parr Whitfield. Molusca and Crustacea of the Miocene of New Jersey. Washington Government Printing Office, 1894. (Cloth, 195 pp., 9×11½.)

Department of the Interior. Bulletins of the United States Geological Survey. No. 118—A Geographic Dictionary of New Jersey. By Henry Gannett. (Paper, 131 pp., 6"×9".) No. 119—A Geological Reconnaissance in Northwest Wyoming. By George Homans Eldridge. (Paper, 72 pp., 9"×6".) No. 120,—The Devonian System of Eastern Pennsylvania and New York. Charles S. Prosser. (81 pp., 6"×9".) No 121,—The Bibliography of North American Paleontology, 1838–1892. By Charles Rollin Keyes. (251 pp., 6"×9".) No. 122,—Results of Primary Triangulation. By Henry Gannett. (401 pp., 6"×9".)

NEW TRADE CATALOGUES.

The Edward P. Allis Co., Milwaukee, Wis., U. S. A.=Catalogue, 120 pp., 6"×9". [Illustrates and describes mining, milling, and smelting machinery, and also the Reynolds-Corliss engines manufactured by this company. This is an important and valuable catalogue, containing much general as well as special information relating to the lines of machinery named.]

Theodore Alteneder & Sons, Philadelphia, Pa., U. S. A.=Catalogue. III pp., 6"×9". [Describing and illustrating a line of drawing instruments, well indexed for reference, and also containing price-list. This catalogue will be sent to any applicant on receipt of 4 cents in stamps for postage.]

The Brownell Car Co., St. Louis, Mo., U. S. A.=Catalogue, 172 pp., 9"×6½", bound in stiff covers. [An elegantly-printed and beautifully-illustrated publication, entitled: "How a Good Car Differs from a Poor One, and How to Get it." The work is practically a treatise on car construction, as well as a description of the cars manufactured by this company.]

Central Railroad Club. Proceedings of the March meeting, 1895, held at the Hotel Iroquois, Buffalo, New York. Reports: Proposed constitution and by-laws. Changes recommended in the rules of interchange. Discussion: Car Doors and Car Door Fixtures. [45 pp., 6"×9", paper.]

Elementary Machine Design by Albert W. Smith, professor of mechanical engineering in the Leland Stanford, Jr., University, California. Stanford University Press. [163 pp., 6"×7¾"+60 pp. of cuts, flexible canvas cover, price $1.75.]

New York Central Iron Works Co., Geneva, N. Y., U. S. A.=Descriptive catalogue and price list, 19 pp., 9" × 6". (1.) [Describing the "Dunning" hot-water heater for warming stores, schools, churches, convents, conservatories, and all classes of buildings by the gravity system of hot-water circulation.] (2) Descriptive catalogue and price list, 55 pp., 10" × 7". [Describing and illustrating the Dunning brick-set and portable self-feed and magazine boiler, surface-burning boiler, soft-coal boiler, base-burning boiler, and sectional boiler, with numerous illustrations and table of capacities and sizes; also describing a line of boilers and stationary engines for power purposes; also containing an illustrated description of Denny's Imperial Gas machine, designed for supplying residences, hotels, stores, mill buildings, or groups of buildings, with a safe and cheap illuminating gas.]

Ransome Subway Co., Chicago, Ill., U. S. A. =Pamphlet, 24 pp., 9" × 6". [Describes and illustrates monolithic subway sewers, electric conduits, drains, cable and electric railroads, ditches, water pipes, tunnels, etc., constructed under the "Ransome" system, in which the cement pipe or ditch is formed directly in the ground where needed, without bricks or joints.

B. F. Sturtevant Co., Boston, Mass., U. S. A.=Pamphlet, 76 pp., 7" × 9½". "The Ventilation and Heating of School Buildings" [being a lesson on the necessity of good ventilation. together with a few illustrations to emphasize the same, and a list of school buildings to point the moral. Probably no handsomer trade publication than this has ever been issued. It is beautifully printed in black and red on cream laid paper, with illustrations of the finest character, and bound in flexible leather covers].

Slatington-Bangor Slate Syndicate, Slatington, Pa., U. S. A.=Manual and descriptive price list for 1895. 23 pp., 3½" × 5". [Essay on slate as a roofing material and its advantages, with practical hints on roofing buildings with slate, directions for shipping, and lists of sizes and prices; also clippings from various papers relating to the slate industry and the business of this syndicate.]

A. L. Ide & Son, Springfield, Ill., U. S. A.= Catalogue, 24 pp., 3½"×6". [Describes and illustrates the "Ideal" engine, with price list of regular sizes kept in stock. Elegantly printed and illustrated.]

Detroit Graphite Manufacturing Co., Detroit, Mich., U. S. A.=Pamphlet, 3⅝" × 6". [Describes the "Superior" Graphite paint and states its advantages, with a list of testimonials substantiating the statement.]

Harrisburg Foundry & Machine Works, Harrisburg, Pa., U. S. A.=Pamphlet, 16 pp., 6" × 3⅝." [Contains an illustrated article reprinted from the Boston *Post*, describing an ideal engine room, claimed to be a dream of cleanliness and beauty; also contains illustrations of a line of simple, compound, and direct connected Harrisburg Ide and Ideal engines.]

Brown and Sharp Manufacturing Co., Providence, R. I., U. S. A.=Catalogue and price list, 530 pp., 3⅝" × 6". [This catalogue contains a large amount of information of value to all mechanical engineers.]

Franklin Leonard Pope

THE

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THE CURRENCY PROBLEM AND ITS SOLUTION.

By Abraham Mills.

THE columns of the New York *Evening Post* have lately been the medium of a very intelligent discussion of the problem of relieving the United States government of the burden of maintaining a gold reserve as the basis of our currency system, and of securing and maintaining an automatic gold reserve. The clearest and most concise exposition of the natural laws of trade governing exports and imports of gold was embodied in the following communication, which explains itself fully:

> *To the Editor of the Evening Post:*
>
> SIR,—Permit me to supply your correspondent G. S. C. with the specific information he requests as to what natural law of trade exists to regulate the international movement of gold in the absence of governmental management. He answers himself when he asks what "natural" law. He concedes there is such a law, and where such exists there is no necessity for man's interference. Like the law of gravity, it always works, and quickly resents any interference. And this is exactly why all the great commercial nations of the world cling so persistently to the gold standard: not only because it is the soundest measure of value, but also because it is the unit recognized as standard among themselves.
>
> Therefore, when from any cause there is great business activity and advancing prices in one country, exports to that country are large and imports from it fall off, and both on account of the high prices there ruling. The foreign investor also sells its securities, tempted by the inflated values which generally prevail during "boom" times. The balance of trade, therefore, rapidly runs against that country, and settlements by gold shipments follow. When the government is not in the banking business, the banks must furnish this gold, and every dollar taken from their vaults diminishes their reserves, and contracts, as four to one, their ability to discount and to accommodate anxious borrowers. Loans are called in, money becomes dearer, prices of securities and merchandise decline, imports diminish, and exports increase, and

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naturally that of gold stops. Like every phenomenon of action and reaction, the latter goes too far. Prices fall so low that they tempt the foreigner, and he sends back gold to invest, because there is nothing else he can send without loss. The banks' reserves are thus quickly replenished, the crisis is over, and business resumes its normal condition.

In this manner all trade is safely regulated in countries using an international standard of value, and commercial crises are rarely known. I do not refer to banking or stock-exchange panics. While they are rare, they do happen in gold-standard countries. But it is wonderful to note how short lived they are and how little damage they do, because there is so quick and beneficent an interchange of standard money. Meantime prices of merchandise are little affected. There is no cessation of industries or prostration of trade, as commonly witnessed in this and other countries cursed by governmental management of the finances. In such countries, the greater the speculative fever the greater demand is there for more issues of legal-tender money, until the final smash comes, to recover from which it takes long years of prostration and of suffering. Our panic of '73 is a recent illustration of this process. The panic of '93 was produced by like causes,—the continual issue of government money,—and its effect would have been more disastrous and longer in duration had it not been for the heroic efforts made by the administration to maintain gold payments.

ABRAHAM MILLS.

Because of the clearness and force of this communication, Mr. Mills was immediately invited to prepare the following paper.—THE EDITOR.

The science of money is almost as abstruse as that of mathematics, and yet every wayside farmer and Knight of Labor is quite sure he knows all about it. Their representatives in congress are, therefore, compelled to vote for what will meet their views, on the penalty of losing their seats. This is the reason it has hitherto been so difficult to get any remedial legislation through congress. But we are rapidly learning our lesson, and in this readiness to be educated lies the great hope of those who think well of the republic. The plain people can be depended upon to act right when they see the right, and it is not too much to say that they see it now. What bothers them most is to discover how to get out of their troubles.

The difficulty of reconciling so many diverse views makes many acute thinkers despair of any improvement, until another panic and a general smash-up shall force the sound men of both parties to unite for the common welfare. When such an eminent publicist as Senator Mills says, as he did in his late speech recanting his silver heresy, that he is deathlessly opposed to banks, and that the sound Democratic doctrine is the providing of all money by the government, one may well despair. An unaccountable hatred of banks of issue is undoubtedly prevalent at the south and west, and derives its strength from the greenback experiment of the war times, and from utter ignorance of the true functions of such banks. In fact, the strength of all cheap-money schemes in this country lies in the absence of local banks to do the actual and legitimate business of each community. It is safe to say that every enterprising man in the rural districts is at this moment sadly hampered in his operations by his inability to obtain currency upon his perfectly good note. That would be simply changing a portion of his fixed capital into current funds, which would be retired when their work was done by being redeemed at the bank of issue. As things are now, he cannot get the necessary facilities to conduct his business, and he cries for any money and plenty of it, without regard to its quality. This demand is a legitimate one, and it points the way out of the currency scrape we are in. Most thinking men have finally come to the conclusion that it is high time we did so, and that the first step is for the government to go out of the banking business. We must leave the management of the finances to the banks and bankers, which is their legitimate business. The currency would thus be subject to the laws of trade, which are as certain in their action as the rise and fall of the tides. Every business man would then know exactly how to act, and every operation would be based upon well-understood conditions. Banish this spectre of a currency panic, and can any one doubt where the enormous accumulation of gold in Europe would go to find profitable employment? This country alone in the whole world offers a field for its use. We don't get it because our public men do not know how to invite it, but, on the contrary, industriously repel it by their silver propaganda and futile discussions.

In the face of these recognized evils, the inertia of our legislators is so evidently absurd that one must seek for a motive sufficiently strong to induce them to persist in their folly. This can be found in the delusion of their farming and debt-loaded constituents that the prices of their products are depressed by the gold standard, and that nothing will save them from ruin but the silver basis. They seem to think that this alone will enable them to compete with the other silver currency countries of the world. By this means they hope to get for their products double the price in silver that they now get in gold. But they are beginning to understand that silver will purchase only half as much of what they must buy; and indeed not so much, as the risk of dealing in a debased currency always adds to the cost of the article bought. The question of wages—the great element of cost in agriculture—also confronts them, and they have horse sense enough to know that they could not long obtain labor in this country for a nominal dollar which would have the purchasing power of 50 cents. Likewise the mechanic is finding out the true meaning of a debased dollar; and so also are the owners of the $5,000,000,000 now invested in saving banks and life insurance companies and coöperative societies.

The debtor class is also frequently cited as one which demands a silver dollar with which to pay its debts. But there are now few, if any, mortgages, or any other obligations, which were not contracted upon a gold basis. This, therefore, is a contention merely for the repudiation of one-half of such indebtedness. In this matter we can also trust the people. Deluded for a time, they are not essentially dishonest, or so reckless of the necessity of public good faith as to deliberately endorse any course of action which squints another way. They are awakening likewise to the fact that the largest debtor class consists of the great corporations, savings banks, and insurance companies; and they don't propose to relieve them of their obligations to the mass of the people at half price. So, on the whole, the chances in favor of the *débacle* of free silver coinage is distinctly favorable. We can now turn our attention to the most serious question of the hour: how to get out of the scrape we are in, and how to mend our ways, that we may avoid trouble in the future, and ensure that prosperity which is fairly knocking at our doors for a chance to live.

Now, what is the trouble? It is the making of money by the general government, and its utterance without reference to the laws of trade and against all financial experience, which has demonstrated, over and over again, that no people can do this without ultimate disaster. We thought we could escape the inevitable penalty by offering to keep this paper at par in gold. So we could as long as the issue was limited to that already existing at the time of gold resumption in 1879. But, with the issue of silver dollars and silver notes came a monthly inflation of fiat money. The bubble was certain to burst the moment the balance of trade went against us. It has burst, and since 1893 we have been making heroic efforts, by resorts to all kinds of expedients, to keep that paper at par. The foreigner looks with derision at the spectacle of the richest and most enterprising people in the world suffering from their ridiculous experiments with the immutable laws of finance. This is the more humiliating when it is recognized how usefully we could employ real money in developing a country like this, and that we cannot get it, at a time when there is such a plethora of gold in Europe as was never known before, which is daily and weekly being augmented from the African and Australian mines. Our own capitalists are at one with the foreigner in distrusting the soundness of the financial situation of this country. Otherwise money would not be loaning at 1 per cent. per annum in Wall street. Nor would there be an almost absolute cessation of railroad building and of other great operations which ordinarily absorb idle capital in this country.

So it comes about that the one thing needful for the capitalist, the laboring man, and everyone who has a living to earn, and even the widow and the orphan, is that our finances should speedily be put upon a sound basis. It must be done this winter, if we are to escape another collapse next year. The paramount question, however, is what? There are any quantity of doctors for the sick patient, but, while all agree in their diagnosis, they radically differ as to the treatment. They acknowledge the government must take steps to go out of the banking business and rid itself of its health-destroying paper money; that it must shake off the responsibility of carrying the ultimate gold reserve, —the only monetary basis the world accepts,—and put it upon the banks, or, in other words, upon the trading community itself. Why the doctors don't agree is because they are not skilled physicians, but simply "bone setters." Lawyers and farmers and professional politicians are not the people to meddle with such an exact science as finance. Up to this time it has all been in their hands, and a sad mess they have made of it.

Now, I venture to say that in an hour one could get together in a bank parlor in Wall street half a dozen men who in another hour would formulate a practical plan to lead us out of our difficulties. I imagine that they would agree that the way is to get rid of the government's demand obligations as fast as practicable, either by paying them off, or by funding them, or both. That is the basis of action. The *method* is the troublesome point, since these demand obligations are the only money of the people, and you cannot take it away without substituting something else, *pari passu*. There are nothing but bank notes with which to do it, and these must be furnished by free banking,—preferably under the Canadian plan of issuing notes under government supervision against the capital of the banks, with an adequate cash reserve of about 25 per cent. of the note issue. The present national bank system may be continued, excepting as to the provision of securing their note-issues by government bonds. There are several objections to this. A bank's capital is locked up as soon as it starts by the purchase of these bonds; and the people's representatives seem bitterly opposed to paying interest on such bonds, while at the same time paying interest for the use of the bank's paper. Another point which must be considered is that, if a new loan is sold abroad to obtain gold, a large part of the issue will inevitably be sold back to this country to be used against bank-note issues, and so defeat the end in view in issuing the bonds.

The short road out of the difficulty which every clear-headed person advocates is to fund the greenbacks. Before this can be done, however, something must be provided in which the new banks can hold their reserves. People talk glibly of all the gold there is in the country. But one cannot go by faith in such a matter,—only by sight.

All the gold we know of outside of the treasury is exhibited in the weekly returns of the banks in the larger cities, and they are not likely to part with it. Of course the necessary amount of gold might be forthcoming, if all the currency were funded. That, though, would be only after an era of panic prices, sufficiently great to bring gold here from abroad for investment. No one would venture to recommend such drastic measures, much less to make laws to bring them about. The bank's reserves must, therefore, necessarily be in the present legal-tender notes, until such time as that currency would be supplanted by something else, or so much of it that the remainder would be no longer a menace. This brings us to the question how to pay it off, or, in other words, how to substitute gold for the notes. We can do it only by getting back some of the enormous amounts we have shipped to Europe, where it is a useless burden to the banks.

The most practical way to accomplish this is by opening a credit for a large amount in London against our 3 per cent. bonds,—in short, by the hypothecation of these bonds for a certain period. During the time that the government is playing at being a banker it must be one seriously. It must get its necessary gold on the best terms it can, and by the use of its credit. There is no novelty in such a proceeding, as we have lately had many examples of currency reforms effected in this way by other countries,— notably Chili and Austria. The details of the plan are immaterial. Supposing, for instance, that the secretary of the treasury were authorized to borrow as much gold as he needs against the pledge of the bonds above alluded to. Drawing upon this fund and thus gradually redeeming his demand notes, he gets rid of the latter, and at the same time replaces them with gold, which gold will take their place in the banking reserves. The mere fact of taking this step would dissipate the fears of Europe as to the soundness of our currency, while at the same time exchange would go down from the sale of the government's bills. Gold would naturally be sent here so largely that the currency question would cure itself with but moderate borrowing on the part of the government. Another good result would be that, with confidence in the government's solvency, the banks of the larger cities would return to their former commendable plan of paying checks in gold for duties, and thus giving the government an independent gold revenue, which it does not get now, as all duties are paid in legals.

But what shall we do with the enormous load of silver bullion in the treasury? In any scheme of currency reform this problem must be considered. It cannot be sold *en bloc*, as there is no market to take such a huge pile. A possible solution of the difficulty could be arrived at, if all the legal tenders and bank bills under $5 were retired and no more issued, thus making a place for silver dollars. France keeps an enormous quantity of silver 5-franc pieces afloat in this way.

With some such reformation of the currency, what may be reasonably anticipated? In the first place, that greatest of desiderata—the taking of all currency questions out of politics—would be accomplished. No scare would then come over every man of affairs at each meeting of congress. Secondly, we should have established an automatic gold reserve in the coffers of the banks, ever responding to the natural laws of trade, and requiring no paternal interference whatever from the government. This accomplished, that sudden chill and semipanic which now comes over every exchange of the country and disseminates itself into every mart of trade and finance wherever a paltry million of gold is exported would disappear.

Something like this must be done on the penalty of a general smash. We cannot drift along in the present makeshift and trembling sort of way. It may not be too much to hope, then, that congress will finally rise to the occasion. A brilliant future lies immediately before this country, with possibilities of great prosperity and even the commercial rule of the world. We have made the first step in progress by reducing our tariff in such a way that we are beginning to compete in our exports of manufactured goods with nations which have hitherto held a monopoly of that trade. Another cause which should have a most potent influence to induce congress to promptly act is the wild speculation in mining stocks and in other crazy schemes which has seized upon the three great capitals of Europe. This has already gone to perilous lengths, and no serious man doubts that a tremendous crash will come sooner or later. That will be no time to negotiote loans or to reform our currency, as we shall inevitably be involved more or less in the financial smash.

A war in Europe must also be reckoned with! Day by day a mysterious, formless impression is growing in its capitals that at any moment their people may spring to arms over the Eastern or some other question. It may be postponed, or it may come as suddenly as did the Franco-German war. But every scheme of *haute finance* must reckon seriously with this probability.

In writing all this I am not unmindful of the adage: "Fools rush in," etc. My apology is that it is the duty and for the best interests of all who have made a study, and have had the facilities for acquiring a practical knowledge of, financial problems to try to impart what they have learned. Those who have not had such opportunities, but yet have the votes, may be depended upon to learn in good time. This is the way of our people.

TAXATION IN THE UNITED STATES.

By Edward Atkinson.

IT is becoming evident that the most urgent problem with nearly every government in the world is how to secure a sufficient revenue without impairing the productive energy of the people of the several nations or States by which continents are possessed. This question is as urgent in some of the richest sections of the globe which have been but recently opened to civilization and commerce as it is in some of the older States in which the limit of taxation has been reached, accompanied by national bankruptcy or a resort to a forced loan by the issue of legal-tender paper money.

It is desirable to compare the relative burden of taxation, and to that end the following statement of the amount of taxes and method of their assessment in the United States is submitted.

The tables give an analysis of all taxes imposed in the United States for national, State, county, and municipal purposes.

The principal source of information on which these statements rest is the special census report made by Mr. J. K. Upton, special expert of the census department of the United States, by whom the receipts and expenditures of national, State, and local governments in the census year 1890 have been compiled and published. The statistical data which are not derived from this report are derived from the official statements of the United States treasury. The estimates of the value of the national product are based on various authorities and upon my own investigations.

Total amount of revenue collected in the census year 1890 for all purposes	$1,040,473,013

Collected by the national government, including postal revenue	461,154,680
Collected by cities and towns, partly estimated, for expenditure by cities, towns, and customarily by counties and States	329,635,200
Collected for expenditure by counties, partly estimated	133,525,493
Collected for expenditure by States, territories, and the District of Columbia	116,157,640
Total	$1,040,473,013

Total expenditures by national, State, and local governments for all purposes	$915,954,055
Sum applied to the reduction of public debts	124,518,958
	$1,040,473,013

GENERAL DIVISION OF THE EXPENDITURES.

Expended by the national government, including the postal service.	$352,218,614
Deduct the postal service, which is mainly recovered from the sale of stamps,—there being a slight deficiency, varying year by year, which is covered under the general expenditures.	66,259,547
	$285,959,067
Expended by States, territories, and District of Columbia, except for public schools.	77,105,911
Expended by counties, except for public schools, partly estimated, in the division with cities and towns.	114,575,401
Expended by cities and towns, except for public schools, partly estimated as above.	232,988,592
Expended for public schools.	139,065,537
Net cost of government.	$849,694,508

Net cost of government per head of population.

$13.65 £2.8049 Francs, 70.747 Marks, 57.305

This expenditure, omitting postal service, may be classified as follows:

BENEFICIARY.		
Pensions paid by the United States government.	$106,936,855	
State and municipal charities.	39,958,816	
Support of Indians.	6,708,047	
		$153,603,718
ADMINISTRATIVE.		
Support of civil governments.	$266,412,130	
Support of army and navy.	57,543,817	
		323,955,947
INTEREST ON PUBLIC DEBTS.		
National, State, and municipal.	82,748,423	82,748,423
CONSTRUCTIVE.		
Support of schools.	145,583,115	
Construction and maintenance of highways.	72,262,023	
Construction and maintenance of public buildings, libraries, and parks.	59,803,844	
Improvement of rivers and harbors.	11,737,438	
		289,386,420
Total.		$849,694,508

The charges to which the people of the United States are subjected, aside from the reduction of public debts, therefore amount per head of population to the following sums:

	$	£	Francs.	Marks.
For beneficiary purposes.	2.47	.5075	12.802	10.369
Administrative	5.20	1.0685	26.951	21.830
Interest	1.33	.2733	1.893	5.583
Constructive	4.65	.9555	24.100	19.721
	13.65	2.8048	65.746	57.503

The area of the United States, omitting Alaska, is a fraction under 3,000,000 sq. miles of 640 acres each, equal in the aggregate to 1,920,000,000 acres, upon which the charge of $849,694,500 comes to a fraction over 44 cents per acre. Less than one-fifth part of this area is under the plough; probably one-half is arable land; probably 25 per cent. in addition is valuable as forest or suitable for pasture; the remainder consists of mountainous sections, or, in small part, of arid desert. These are merely general statements, not intended to be exact. The charge or tax for public purposes, if assessed wholly upon the portion of the land which is in productive use or under the plough, would average approximately $2.00 per acre. But it will be remarked hereafter that a large part of the municipal assessment is upon real estate in cities. It is not probable that the tax which falls upon the owners or occupiers of arable or pasture land comes to an average of $1.00 per acre.

A more important consideration is the proportion of taxation or public expenditure to the gross income of the people. It is, of course, impossible for any one to reach other than an approximate estimate upon this point. Official estimates are made by the census authorities and by other officials of the value of farm products at the farms, of the value of forest products at their source, of the value of mining products at the mines, and so on. We also have data regarding the value of manufactured products at the factories. But there are of necessity a great many duplications in these estimates, which cannot be wholly eliminated,—as, for instance, the conversion of grain into meat and dairy products; the conversion of wood and metal into buildings, tools, and implements; and the conversion of fibers into fabrics. I do not, therefore, regard these computations as anything but material to be applied for the purpose of estimating the annual income or product. They would be sure to mislead, on account of these necessary duplications, if accepted as final.

I have in several instances extended the valuation of the crude products of the country through their various transformations into finished goods and wares by methods of a somewhat complex order, which have been satisfactory to myself.

I have also proved the results of such estimates approximately by working from the known factors of the average earnings of all classes in the community who are occupied for gain,—adding taxes, profits, and other elements that enter into the cost of production and distribution. By these methods, which are dealt with in my book upon "The Distribution of Products" (G. P. Putnam's Sons), I have satisfied myself that the value of our national product in 1880, at the points of final distribution for consumption, came to $200 per head, including that part of each crop which is consumed upon the farms.

In the interval between 1880 and the census of 1890 the quantities of nearly every product were greatly increased; the cost was diminished; the means of distribution were augmented; the wage or proportion of product falling to those who are customarily named "the working class" was largely augmented; but the prices of nearly every important class of products were much lessened at the points of consumption, although maintaining a relatively steady value at the points of production.

There is, of course, a very great variation in the distribution of such taxes, the taxes in cities being ratably very much higher per capita, or by the measure of property, than they are in the agricultural districts.

Of this sum total of local taxation the amount collected by direct *ad valorem* taxes upon real estate was $443,096,574. The remainder was derived from special taxes on franchises, licenses, and other minor sources.

It therefore follows that about one-half the total revenue collected from the people of the United States for all purposes is derived from direct taxes upon property, and about one-half from duties, excise taxes upon articles of common or general consumption, or licenses and taxes on franchises. This division may be justified in consideration of the fact that the protection of property, the provision for highways, and other similar functions, rest upon the States, counties, and towns, while national defence and the protection of persons and the establishment of personal rights at home and abroad rests upon the central government.

Taxes for the support of local self-government are therefore mainly collected from assessments upon property; the revenue for the support of the national government is collected almost wholly from articles of common consumption.

The foregoing memorandum is submitted with a view to the adoption in other countries, or by officials thereto designated by the United States government, of some method of ascertaining and sorting the respective revenues and expenditures of other countries, to the end that the relative burden of taxation and the relative cost of conducting the governments of nations, States, or municipalities may be compared.

The undersigned has made an attempt to set off the items of revenue and expenditure of this and other countries one against the other, but has failed, the reason being that the methods of accounting differ greatly. It is therefore difficult, if not impossible, for one who is not conversant with the systems of account in other countries to set off the several items of expenditure, or even of revenue, one against the other, with any certainty or precision. The following reasons for this undertaking are submitted.

The world is becoming more and more a neighborhood of which the different members can and will supply each others' wants in a continually increasing measure, to the profit and benefit of all who are served by the conduct of commerce, the surplus of one nation being exchanged against the surplus of another to the mutual profit and benefit of all. This interdependence of States and nations has asserted itself throughout the last century in spite of wars, conventions, treaties, tariffs, variations in the unit or standard of value, and all other obstructions.

It is manifest that by far the greater part of the commerce or exchange of services among men is of necessity limited to the domestic traffic. The international exchanges constitute a very small proportion compared to the home trade. But, on the other hand, diversities of climate, soil, and conditions create international commerce, whereby one nation may relieve itself of an excess of some product, the other securing what it requires. It is noticeable that in the early part of this century and the latter half of the last this commerce asserted itself so strongly as to have led the smugglers by whom the prohibitions of the tariff of the era were overcome to be called the "fair traders," the legal fault being condoned in public estimation.

During the last half century the applications of science and invention have rendered international commerce more and more necessary and useful. We can already foresee yet greater and more beneficent influences from the applications of modern science in the opening of the ways of commerce both by the canals already constructed (yet more when those which are planned shall be completed) and by the extension of the railway and steam-ship service in continents which have only been opened to trade within the present generation.

The Suez canal has brought Asia and Europe into a close neighborhood. The projected canal between the Atlantic and the Pacific, if constructed, will alter the balance of the trade of the world. The canal which unites the great lakes in the United States around the falls of Sault Ste. Marie has exerted a most beneficent influence both upon the United States and Canada, bringing the timber, the ores, and the grain of the far north-western territory to the uses of the bread-winner in the eastern parts of the United States, in Great Britain, and upon the continent of Europe.

The annual tonnage which passes through the Sault Ste. Marie canal, 300 miles north of Detroit, at the present time far exceeds that which passes through the Suez canal year by year. The opening of the canal at Kiel may be noted as a notable event in peaceful commerce.

To whom, then, will fall the paramount influence in the next half century? It is with reference to this matter that the problem of comparative taxation assumes great importance, since one great factor, if not the prime factor, in the effort of one nation in competition with others for the supply of the wants of the world consists in the relative burden of taxation. All profits, rents, wages, earnings, and taxes must be derived substantially from the annual product, a small part of the product of the preceding year being brought over to the present, and a corresponding part of the current year's product being carried over to the next. On the whole, mankind is always within 1 year or less of starvation, and within 2 or 3 years of being naked and homeless. The commerce of the world must of necesssity go on in order that mankind may continue to exist, while the comfort and welfare of great masses of the people of every country will be commensurate with the freedom with which this commerce is conducted and the lessening burden of what may be called the destructive taxation of war or the constant preparation for war.

Regard being given to the burden of taxation, its relative influence upon the welfare or illfare of the people consists not so much in its proportion to the gross product as in its ratio to the margin of profit which may be derived from agriculture, manufactures, or commerce. That profit, whatever it may be, is the incentive to the capitalist to develop all the arts, both of production and distribution. If we compare the ratio of taxation of any State or nation to the gross value of its annual product, it may not appear a very serious matter. If we, however, compare the rate of taxation with the probable ratio of profits that may be derived from any particular art, it becomes manifest that the most lightly taxed nation will secure the largest profit, and may therefore take to itself the greater share in production.

If it should be proved by comparison of the relative burden of taxation, on the plan of the present paper, either in ratio to population, in ratio to arable land, or in ratio to the net profit which may be derived from production, that the burden of constant preparation for war had become unbearable, and can be no longer borne without disaster; if it should be proved that the destructive taxation for war purposes is the prime cause of want and of pauperism,—then the remedy for such wrongs may be in sight. If it should prove that the nation which contains within its own area the greatest natural resources, the best schools, and the smallest army, and which supports a navy only for the protection of commerce, and not for its destruction, may hold the paramount position among the machine-using States and nations, then it would follow of necessity that the principle of liberty must prevail, and must lead in the end to the removal of militarism and of government by privilege, and, lastly, to the abatement of the corresponding evils of Nihilism and Communism, which are the complement of government imposed from above without the consent of the governed.

It is to this end that I suggest to my coadjutors in economic science the expediency of devising plans and methods for establishing a systematic study of the comparative taxation of different countries.

The advance in money value is not, therefore, to be estimated at the same ratio with the increase in quantity. I am satisfied that the annual product of the census year 1890 divided by the population amounted approximately to $225 per head. On this basis the gross value of our annual product in 1890, disregarding small fractions, came to $14,000,000,000. The net expenses for national, State, and municipal purposes in that year amounted to $849,694,508, showing that a fraction over 6 per cent. of the total product was devoted to the support of government.

The margin of error in this estimate is not large. It may be affirmed with almost positive certainty that the proportion of the product assigned to the support of the government in 1890, and to such payment of public debts as was made in that year,—a total of $1,040,473,013,—could not have been less than 6 per cent. of the gross product, probably amounted to 7 per cent., and could not have exceeded 8 per cent., the variation in per cent. depending upon a greater or less valuation of the product.

The next point which calls for attention is the relative burden of the national taxes as compared to those which are assessed for State and municipal purposes.

In 1890 the total expenditures of the United States government, less the postal service, amounted to $291,028,440.

	$	£	Francs.	Marks.
Per capita	4.749	.9578	24.614	19.957

This sum could not have been less than 2 per cent. upon the annual product, and could not have exceeded 2½ per cent.

The average expenditures of the United States government for 15 years, from 1880 to 1894 inclusive, have been very nearly the same as the ratio in 1890,—at times a little less, later a little more.

Under the present administration these expenditures are being diminished ratably to population.

The average annual per capita expenditures for a period of 15 years has been as follows:

$	£	Francs.	Marks.
4.89	1.0048	25.345	20.525

The revenue of the national government is almost wholly derived from duties upon imports and excise taxes on liquors and tobacco. The government has a small income from sales of public lands, taxes on bank-note circulation, and other small factors which do not need special treatment. The following tables give a general conception of the sources of national revenue from 1880 to 1893.

Tax on domestic spirits, yielding per head	$1.312	
" " " beer " " "	.373	
" " " tobacco " " "	.605	
" " foreign liquors " " "	.137	
" " " tobacco " " "	.160	
Total tax on liquors and tobacco		$2.587
Tax on sugar for the first 11¼ years, at the rate of .925 per head, tax then removed :		
Average for whole term	.764	
Small internal taxes	.077	
Miscellaneous permanent receipts, sales of public lands, etc	.534	
		$1.375
		$3.962
Duties on all other imports than liquors and tobacco		2.576
Total taxation per head		$6.538

The subsequent table gives the expenditures in detail for 15 years, 1880 to 1894 inclusive.

The average cost per head of each department of the national government, aside from postal service, for 15 years has been as follows :

Cost of civil service administration – legislative, judicial, consular, etc	$ .39640
Public buildings for civil use – post-office, custom-houses, etc	.07386
Support of army	.56610
Cost of forts, etc	00600
Improvement of rivers and harbors	.18600
Support of navy	.25260
Construction of naval vessels	.08826
Miscellaneous—District of Columbia, etc., refund of taxes, unlawful sugar bounties, premium on bonds purchased, etc	.92266
Total	2.49188
Interest on public debt	.90880
Cost of government and interest	3.40068
Pensions	1.48760
Total expenditure	4.88828
Taxation for national purposes in all forms, per head	6.53800
Expenditures of all kinds	4.88828
Difference	1.64972

Making no allowance for a slight difference in cash in the treasury on June 30, 1879, as compared to June 30, 1894, this difference of $1.65 per head enabled the treasurer to meet the postal deficit, to pay for the support of Indians and for extinguishing their title to large areas of Indian land, and to reduce the public debt by over $1,100,000,000, besides paying a heavy premium on the bonds purchased.

The national debt at its highest point, a few months after the end of the civil war, was a fraction under $3,000,000,000. It had been reduced to less than $1,000,000,000, when new loans were effected to the amount of about $500,000,000 for the purchase of silver bullion, which rests mainly in the treasury in the form of silver dollars or of uncoined bullion. If that reserve or deposit of silver is estimated at its market value and deducted from the present debt of the United States, the net amount which we now owe is approximately $1,100,000,000.

It is now manifest that, in the natural course of events, the per capita expenditure of the United States will diminish ratably to the population by the falling in of pensions. It may therefore be assumed as approximately certain that a continuation of the national taxation at the present amount of $5.00 per capita will meet all the expenses of the government, with a sufficient surplus to pay the remainder of the national debt within the next 20 years.

The taxes which are imposed for city, county, and municipal purposes are assessed almost wholly directly upon property. The method of assessment varies in the different States. It is customary, however, for these taxes to be levied in one assessment. In New England, which is under the town and city system of government, all the taxes are assessed by town and city, the sum required by the county being paid over to the county, and the sum required by the State being paid over to the State.

Total expenditures in 1890 for the cost of local government..	$558,666,068
To which may be added the sum applied to the reduction of State, county, and municipal debts..............................	15,582,892
Bringing the total assessment to..........................	$574,248,960

The amount of this assessment per capita was as follows:

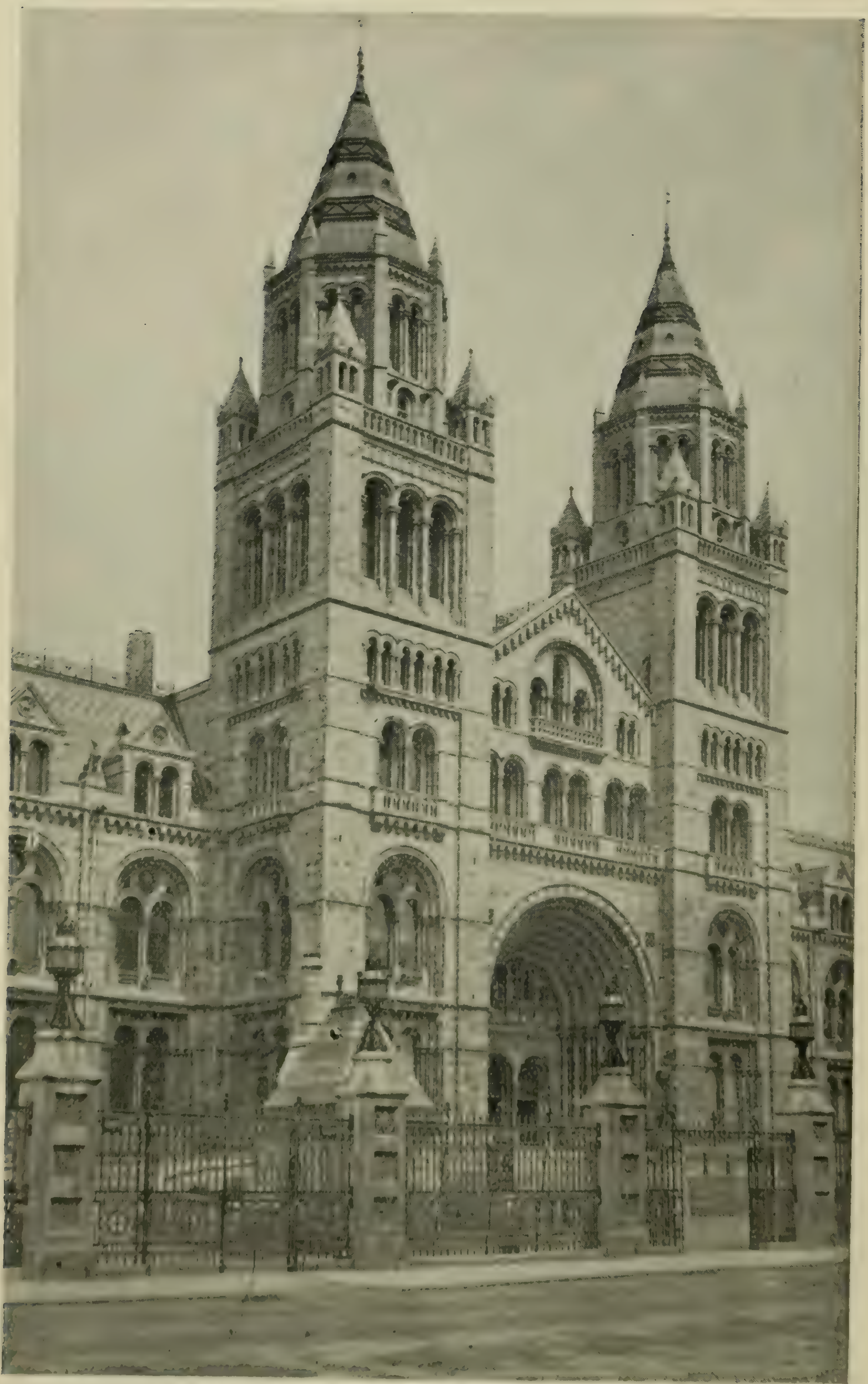
$	£	Francs.	Marks.
9.22	1.8946	47.787	38.707

CONTEMPORARY ENGLISH ARCHITECTS AND THEIR WORK.

By H. Heathcote Statham.

THE aims and characteristics of English architecture at the present moment are essentially different from those which have prevailed in England during the previous portion of the century; so far, that is to say, as respects the work of those who in an artistic sense are her leading architects. There is no doubt a great amount of dull, commonplace, almost mechanical architecture, not worth calling "design," carried out by people who have what is called "a large practice" and who have achieved a commercial success; and there may perhaps be a larger proportion of such work, in comparison with real architecture, than is found in France or in the United States, though, in regard to the latter, I can judge only from published illustrations. But, if we take the men who are admittedly prominent among the English architectural designers of the day, I believe it will be found that in regard to quality, if not quantity, English architecture is not inferior to that of any other nation at the present moment. The French, it must be admitted, are superior to all the world in the planning, designing, and detailing of a large and grandiose building of the classic type, but it can hardly be questioned that English architects could give them many a lesson in the qualities of grace, variety, picturesqueness, and refined taste in buildings of a less pompous class. The development of original and picturesque types of architecture, especially domestic architecture, of late years in the United States has been watched with much interest from our side of the Atlantic, but I do not think we could reasonably be expected to feel that the American architects are our superiors in this respect, except in so far as they have larger and more extended opportunities.

For the essential change in English architecture, referred to above, consists in the fact, that we are at last really beginning to shake off mere revivalism. In the Gothic revival everything ran in one groove, and the most learned and conservative revivalist was considered the best man; and, when the "Queen Anne" revival took its place, it was prophesied that this was only the commencement of another phase of copyism. But the result has turned out otherwise. Partly perhaps because the phase of architecture seized upon was in itself less pure, less perfect, less of a real "style," than the Gothic, the generation which began by adopting the manner of the Queen Anne or

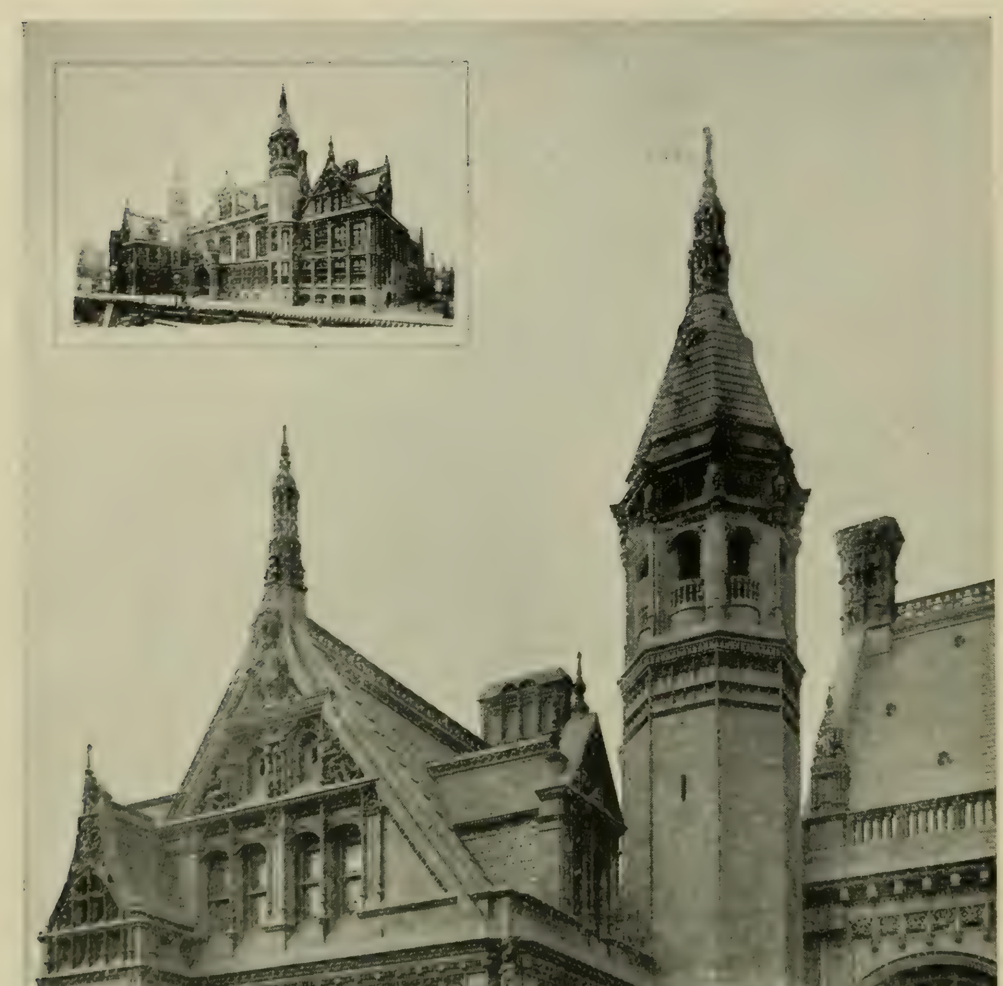


CENTRE BLOCK NATURAL HISTORY MUSEUM, SOUTH KENSINGTON.
BY MR. A. WATERHOUSE, R. A.

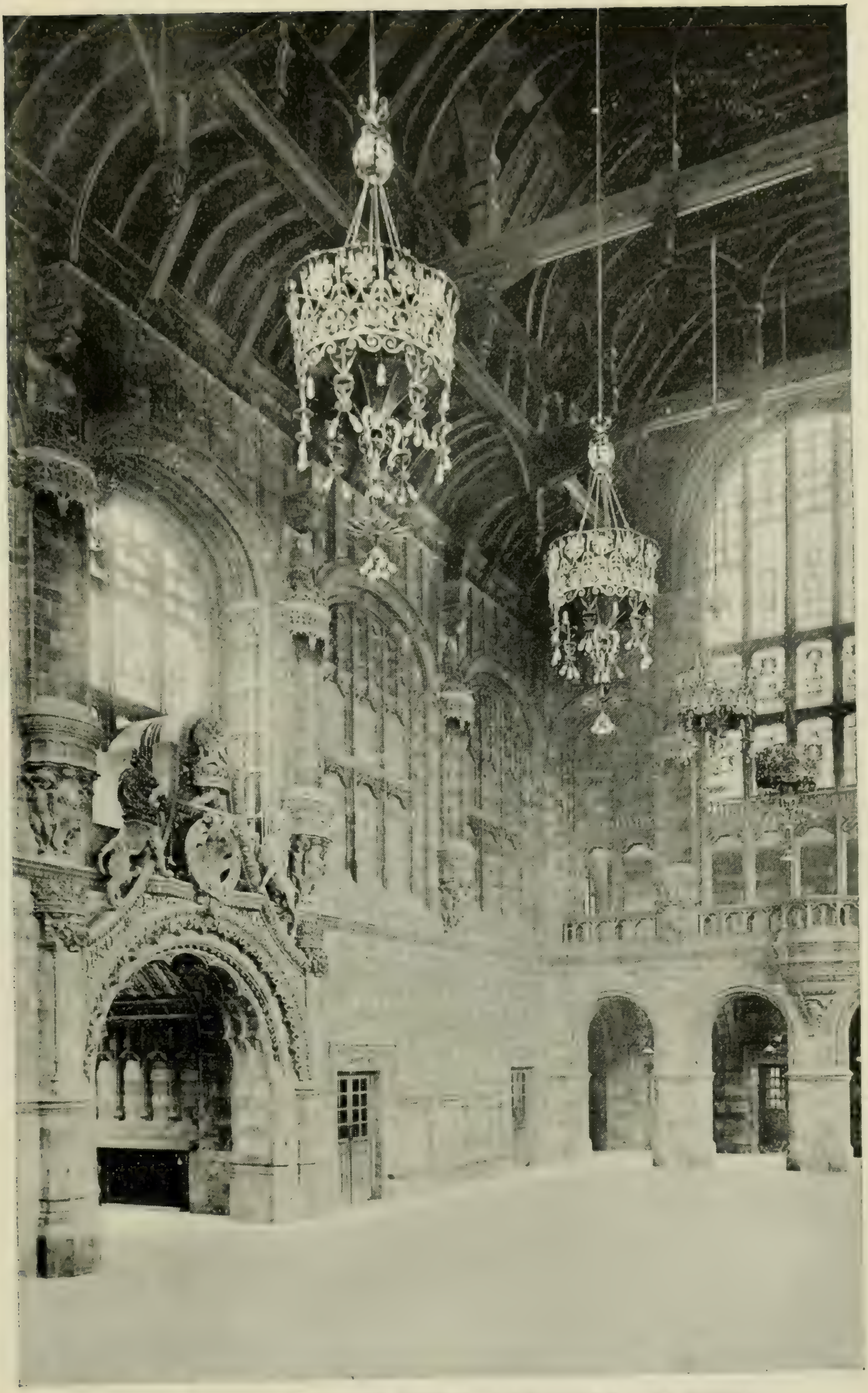
Jacobean architects has not remained bound to this, but has developed it in various directions, in buildings which are by no means mere reproductions of a style of the past, but which display at all events perfectly novel combinations of old materials, and such as give every promise of further development. To a slight extent English domestic architecture on a small scale has taken some hints from what I venture to call the *ultra*-picturesque type of country-house recently developed in America; but this only occasionally. In the main I think it may be claimed that the best recent work of English architects is as original as anything that their American cousins can show.

Mr. Waterhouse, whose name is perhaps more widely known than that of any other English architect of the day, belongs artistically rather to the last than the present generation. He rose into fame, in the first instance, through his Manchester assize courts (which he gained as the result of a very large competition), when the Gothic revival was still in full swing; but he was no mere revivalist. In his adaptation of Gothic to municipal structures, street buildings, and modern domestic architecture, he evolved a manner entirely his own, which was recognizable at a glance, and which received the compliment of imitation on a most extensive scale. Now that the taste for medievalism has declined, his work of this type is unjustly depreciated by many of the younger men of the day, who forget that, in carrying it out, he was only doing better than most others what every one was doing at the time. Of late Mr. Waterhouse's style has been a good deal modified, and is now more eclectic than formerly. He was largely instrumental in the introduction of terra-cotta facing in place of masonry, and no doubt one result of this, both in his own terra-cotta architecture and that of his imitators, has been to lead to a too great exuberance of detail, a want of repose. This is the defect in his largest building of this type, the Natural History Museum at South Kensington. Yet there is no large English building of the day which has more decisive claim to originality. It resembles nothing that preceded it, and cannot be pigeon-holed under any archæological formula. Moreover, Mr. Waterhouse has been throughout his career a thorough architect, in the most complete sense of the word. He is a master of the art of planning, a subject in which some of those who dislike his school of design might well take lessons from him, and in every other sense has always had a thoroughly practical grasp of the art of building.

Mr. Aston Webb may perhaps be considered in a sense the legitimate architectural inheritor of Mr. Waterhouse; not that he consciously imitates the style of the former, but he holds very much the same kind of position among the younger generation of architects.



PART OF STREET FRONT, NEW LAW COURTS, BIRMINGHAM.
BY MESSRS. ASTON WEBB AND INGRESS BELL.



CENTRAL HALL, NEW LAW COURTS, BIRMINGHAM. BY MESSRS. ASTON WEBB AND INGRESS BELL.

Like Mr. Waterhouse, he is a master of plan; like him, he is apart from the newer tendencies of English architecture, and is not regarded with much sympathy by the adherents of the new school. His Birmingham law courts, won in competition in conjunction with his friend and frequent coadjutor in large works, Mr. Ingress Bell, is a terra-cotta work, in which the facilities given by the material for luxuriance of detail are carried further than Mr. Waterhouse ever carried them, and certainly I think too far, though the picturesque general effect of the façade cannot be questioned, any more than its originality and novelty. Moreover, the Birmingham law courts is one of the best planned buildings in England, old or new. This building mainly raised Mr. Aston Webb to his present position among English architects, but it has since been his fortune to win two of the most important competitions of the day,—those for the completion of South Kensington Museum and for the proposed "Christ's Hospital" schools at Horsham, the carrying out of both of which appears to be indefinitely postponed for want of funds. The Christ's Hospital design, won in conjunction with Mr. Bell, is one of the most remarkable plans I have ever seen, and, if the building, or, rather, series of buildings (for it is a little town in itself), is ever carried out, it will go far to revolutionize public-school planning in England. Mr. Aston Webb is a prominent member and vice-president of the Institute of Architects, and will probably be its next president.

The last remark serves *infandum renovare dolorem.* It is a matter of faith—nay, of ardor and burning zeal—among several of the best men of what may be called the new school of English architects to have nothing to do with the Institute, and even to scoff at and revile it when opportunity occurs. Why they adopt this attitude I do not know, and I do not believe they know themselves; at all events, I have never heard any logical or intelligible reason for it. As far as I can understand, the opposition professes to be based on the theory that architecture is a pure art, like sculpture and painting, and that the Institute treats it as a science and a profession also. It seems to me that facts and common sense are on the side of the Institute; but one cannot well enter on so large a question here. I will only remark that, while it must be admitted that very bad *designs* have been made by architects who are members of the Institute, some of the worst *plans* ever made have been produced among the "art-architects" who despise the Institute.*

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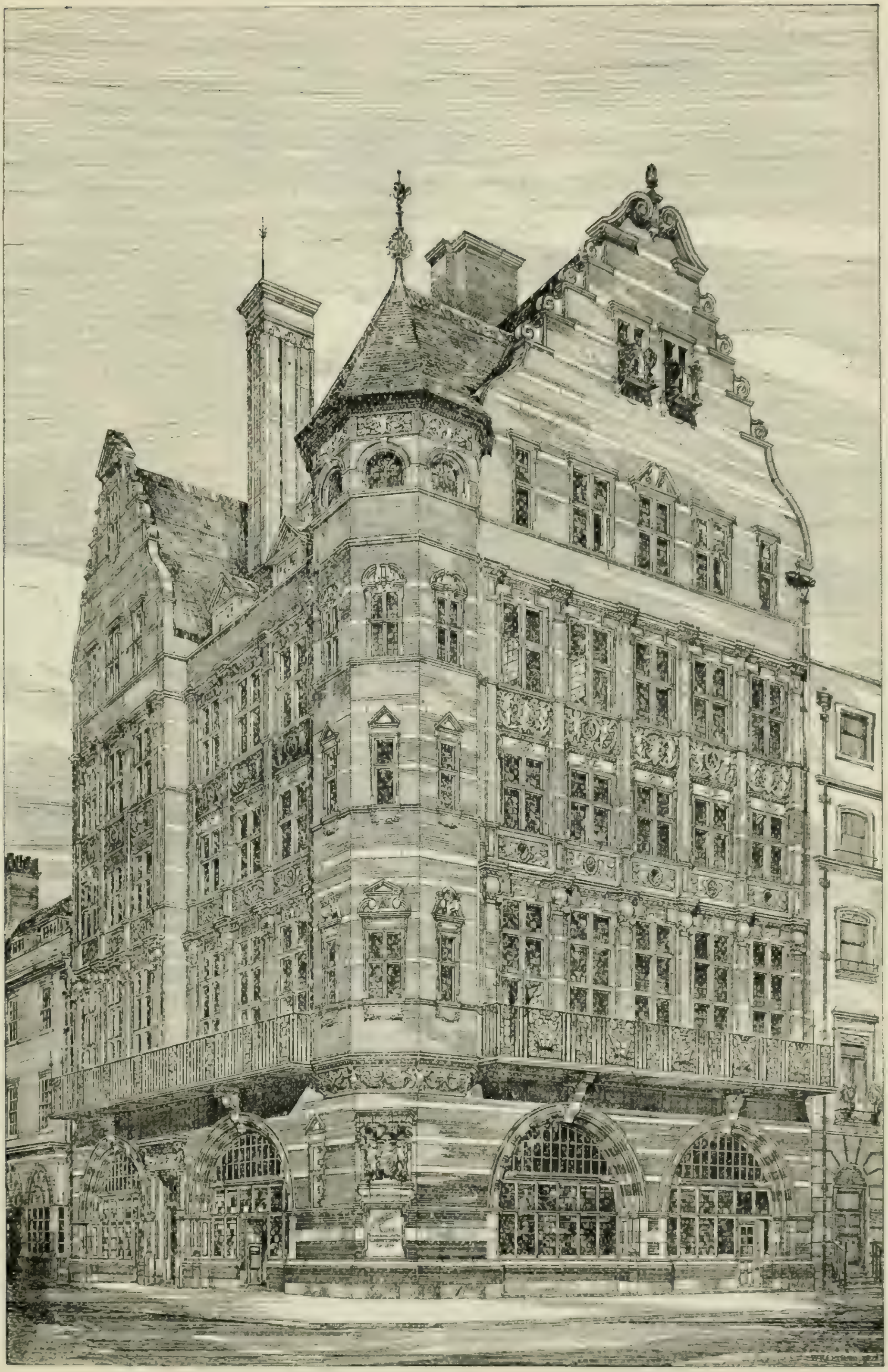
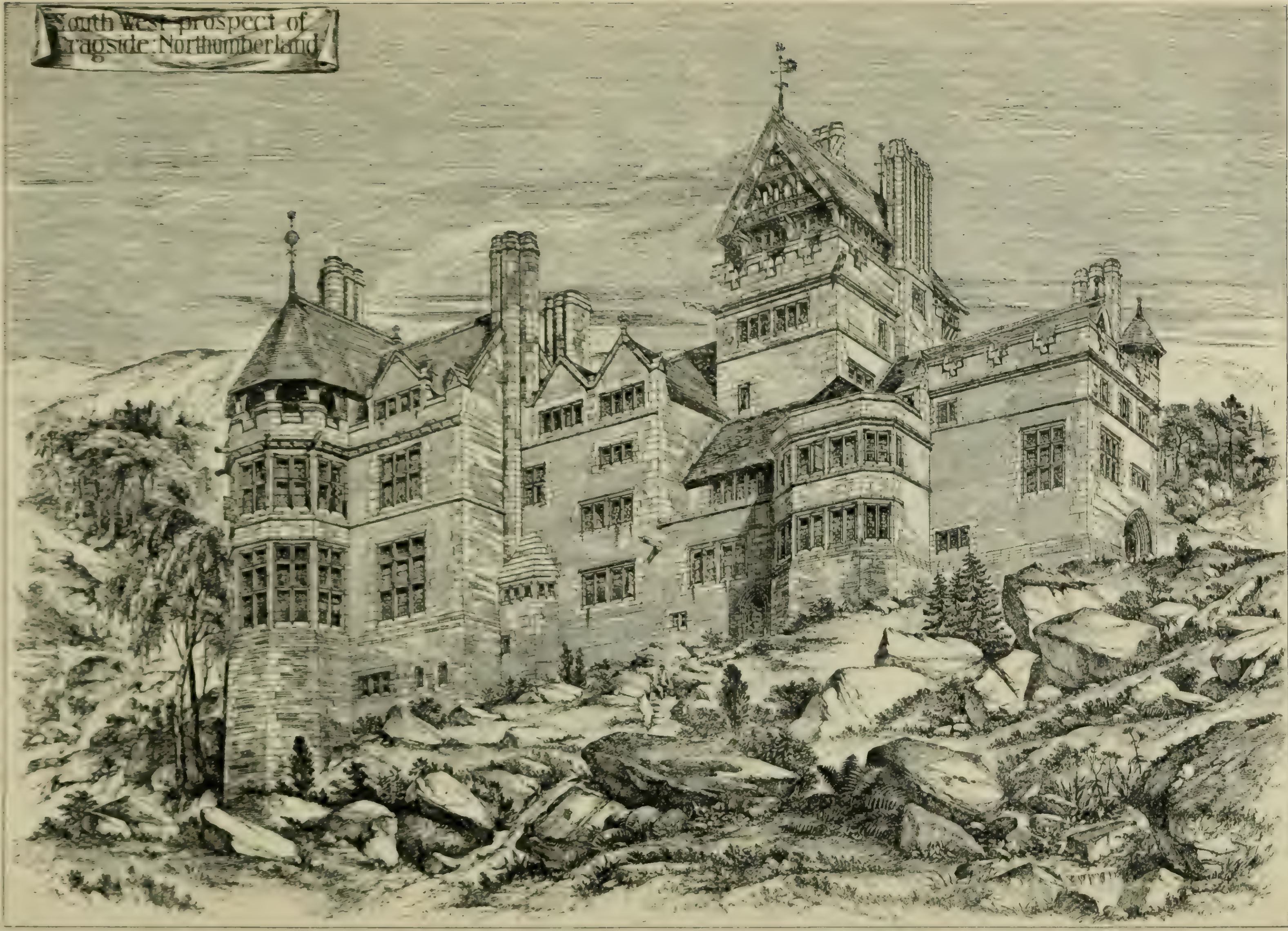
* It may be as well to add, perhaps, that it is "common knowledge" that some of the outsider architects who consider themselves artists *par excellence* have commercial interests in firms producing artistic fabrics of one kind or another, and this fact would in itself debar them from membership of the Institute, which maintains in its by-laws the wholesome provision that its members shall have no commercial interest in the sale or employment of any material used in building.



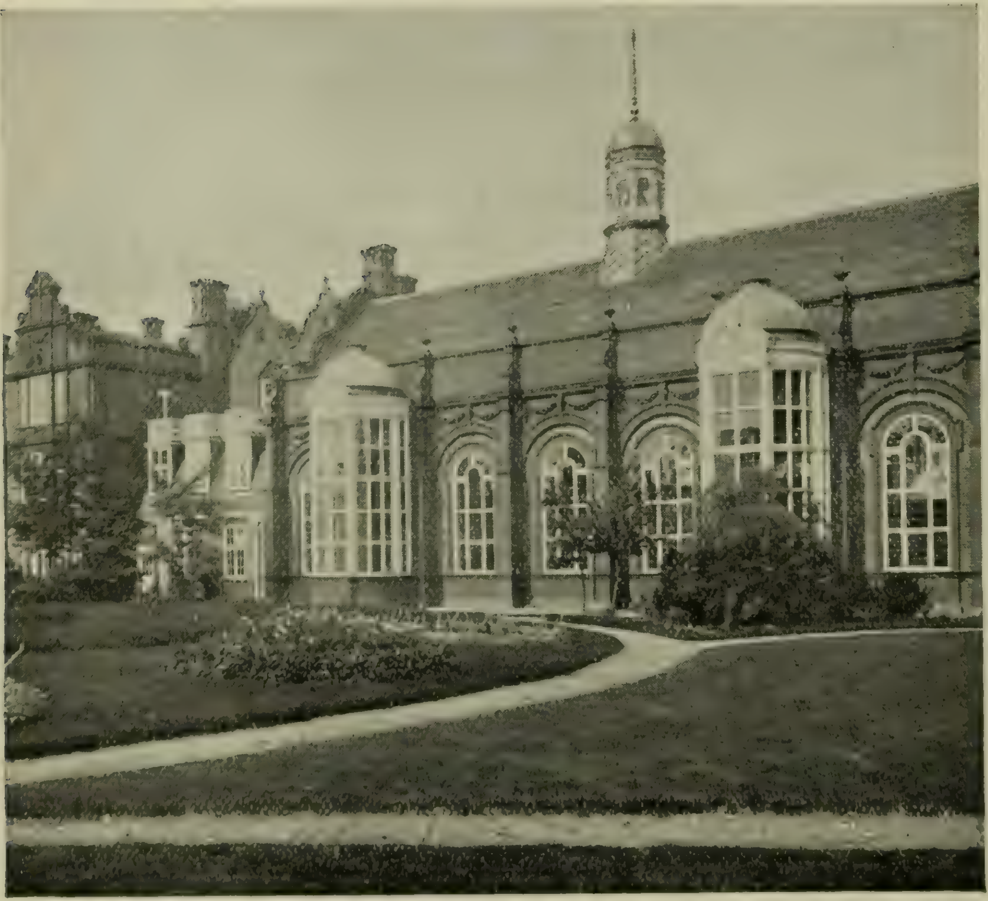
OFFICE, ALLIANCE ASSURANCE CO., ST. JAMES ST., LONDON. BY MR. R. NORMAN SHAW, R. A.



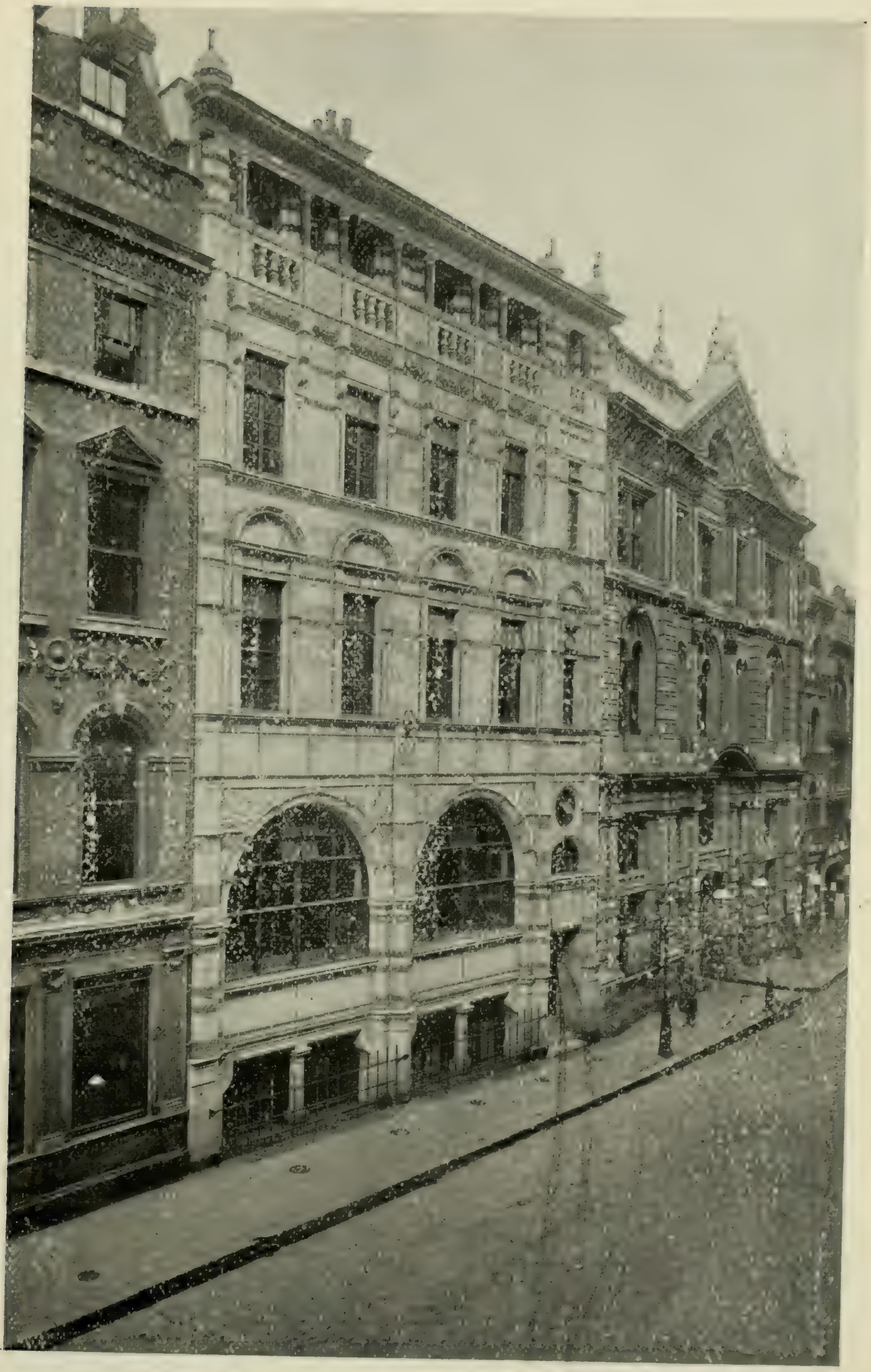
"CRAGSIDE," NORTHUMBERLAND. BY MR. R. NORMAN SHAW, R. A.

Facile princeps among these irreconcilables, and perhaps among English architects, is Mr. Norman Shaw, R. A.: at least, if a *plebiscite* were taken as to who was our leading architect, I think he would come in by a large majority, though, oddly enough, he has never had the chance of producing any building on the largest scale, and his work is mostly either domestic or street architecture. And, if it be admitted that the great object of architecture is to make buildings interesting, I do not know where Mr. Shaw's equal is to be found, either in France or America. His variety of treatment seems endless; he never repeats himself, and, while he adopts many details which are to be found in Elizabethan, or Jacobean, or Queen Anne architecture, they do not suggest copyism; they are combined and treated in a manner of his own; they may be details often corrupt in themselves, such as the pyramid finials of one period of English Renaissance, but there is a charm about the grouping of the whole which is entirely his own. It is seldom very easy, either, to label or classify Mr. Shaw's buildings as to style; and, as long as the result is pleasing, that is one of the best things you can say about a design. There are two tendencies discernible in his buildings, some of which incline more to late medieval types, others to late Renaissance; "Cragside," Lord Armstrong's house, is an example of the one, the Alliance assurance offices in St. James's street of the other. Mr. Norman Shaw, too, is no mere artist in architecture, but a practical constructor and the inventor of a new form of house drain which has been a good deal used. What he would have made of a grand building on the largest scale, such as a first-class town hall, we have had no opportunity of knowing; possibly his style might not have come out so successfully or suitably in that form; but at all events we owe to him an almost unprecedented number (for one man) of picturesque and interesting buildings on a medium scale. The most important public building he has carried out, the block of police buildings at New Scotland Yard, is, however, a great success, and is marked by a curious bit of original character; the walls were commenced in granite provided by convict labor, the supply of which was for some reason stopped when the building was about one-third up: the architect merely finished off the granite at a course level and went on in brick, without even an intervening string-course; and this naïve acceptance of the situation gives half its character to the building.

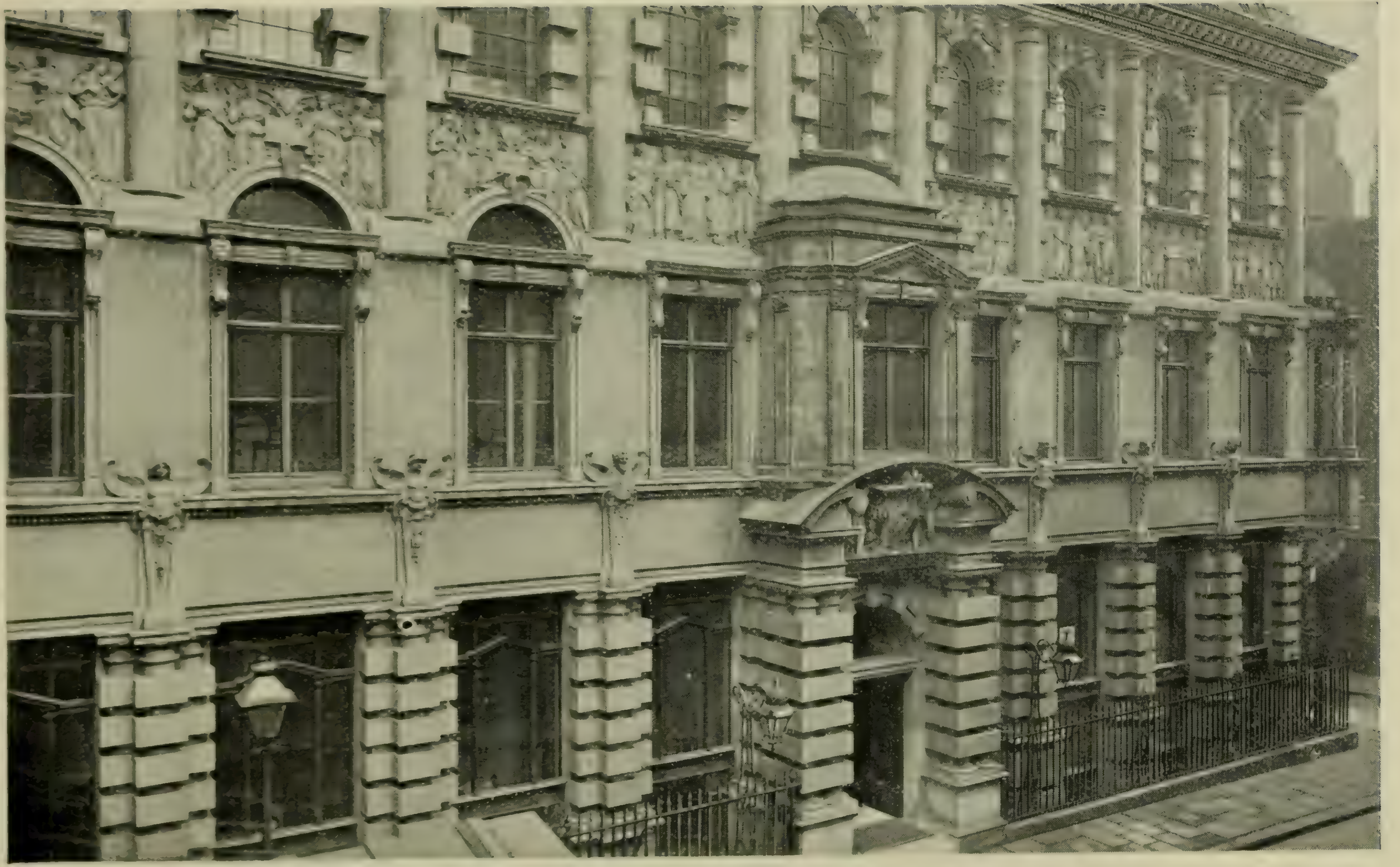
Mr. T. G. Jackson, A. R. A., another of the "Irreconcilables," and the last architect elected member of the Royal Academy, has founded his style mainly on late Jacobean architecture, and, with less of picturesqueness and variety than Mr. Norman Shaw, and more conservative in his tendencies, has established a deserved reputation for refinement and grace in the treatment of neo-Renaissance architecture. He has become in an especial sense the architect of modern Oxford, and in the new Examination schools and the new buildings of All Souls and Trinity Colleges and others, has produced architecture which has a remarkable affinity with the *genius loci;* so much so that, when some of his buildings get a little time-worn, it may be rather difficult to distinguish them in appearance and character from the buildings of the older date to which they are assimilated. This is perhaps going a little far, but his Oxford works nevertheless cannot fail to please from their refinement of detail, and it is on record that, when the London "Architectural Association" visited Oxford on their annual excursion 3 or 4 years ago, the members very quickly deserted Wren's chapel at Trinity to study in preference Mr. Jackson's buildings flanking one side of the "quad." In his school buildings at Radley and Uppingham Mr. Jackson has leaned towards late Gothic types, which he treats with equal refinement and good taste; and that he has versatility is further shown by his remarkable design for the decoration of a



NEWNHAM HALL, CAMBRIDGE. BY MR. BASIL CHAMPNEYS.



OFFICES, LEADENHALL ST., LONDON. MR. T. E. COLLCUTT.

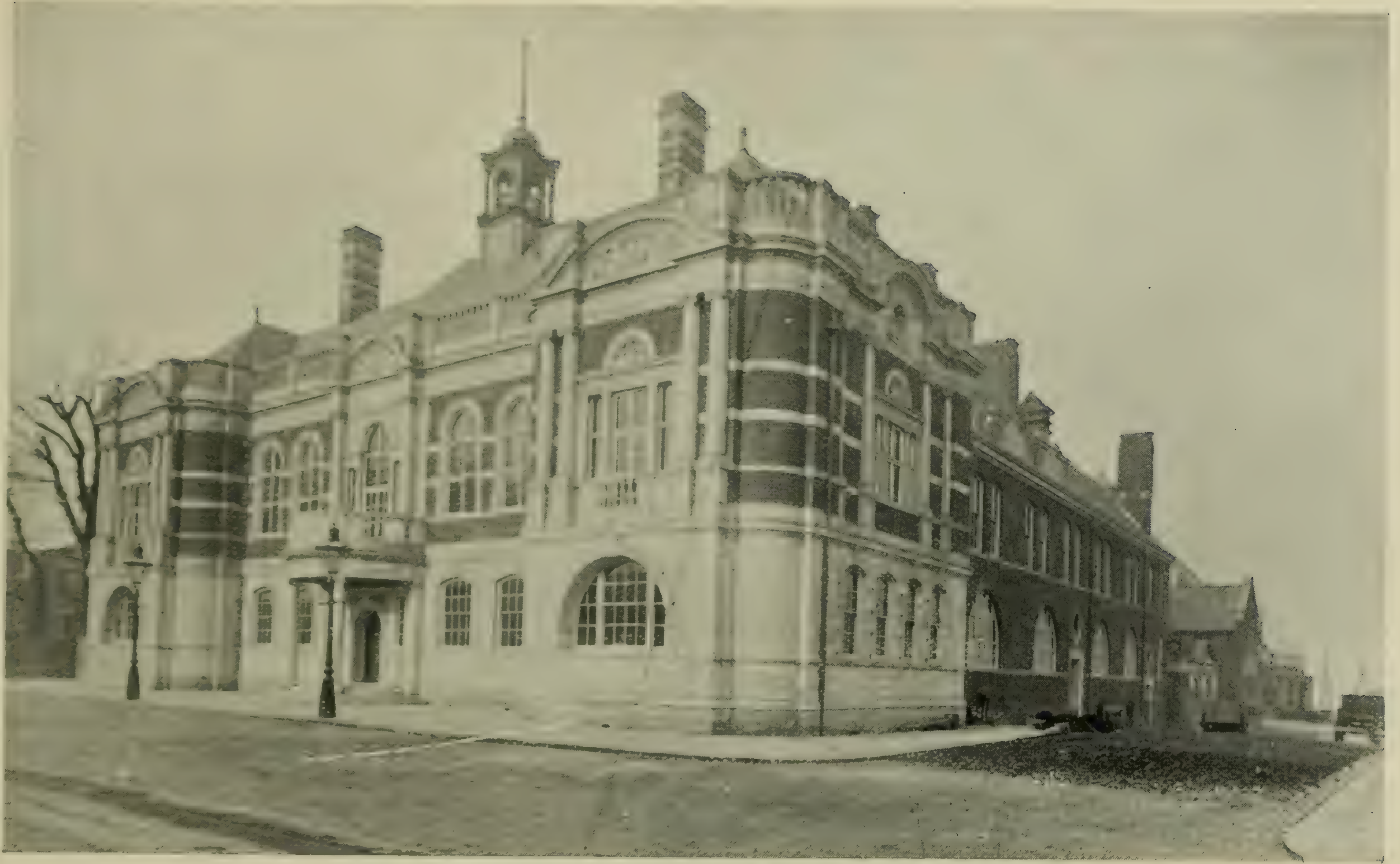


OFFICES OF THE CHARTERED ACCOUNTANTS, LONDON. BY MR. JOHN BELCHER.

piano in Intarsia work, which attracted great attention in London at the time. Another architect (also a non-Institute man) who has done a good deal of University architecture in a very refined manner is Mr. Basil Champneys. Though he has produced one or two charming buildings at Oxford, Mr. Champneys is better known at Cambridge, and more especially at Newnham, where his Newnham Hall is a charming specimen of a simple, but refined, architecture based on late English Renaissance, but with an original treatment of his own. Mr. Champneys did a good deal of Gothic work formerly, but seems now to incline generally to a classic type of design, which he always treats in a sober, refined, and reticent manner, and in which he has established a certain recognizable style peculiar to himself.

Mr. T. E. Collcutt, whose principal work, only just completed, is the Imperial Institute (gained by him in a limited competition of six architects), is an architect whose work has had a great deal of influence on that of his juniors in this generation. He early established a manner of his own, based on English Renaissance, which was as distinctive and well-marked as Mr. Waterhouse's early style based upon Gothic, and has had as many imitators. His general manner is well illustrated in the front of the offices in Leadenhall street, which is one of his most recent works. It is characterized by the combined employment of arches and pilasters, but always in a very flat manner, and with certain favorite devices peculiar to himself (at least until others began to imitate them), such as the termination of gables or pilaster groups with a little curved pediment, like that seen in the centre of the Leadenhall street elevation. When spread over a building the size of the Imperial Institute, this style seems rather wanting in force, but it is always refined and pleasing. The Institute is a well-planned building; the central hall is a fine interior with a timber roof treated in a very original and effective manner, and the upper portion of the tower is a good piece of design.

No work of the neo-classic school has excited more interest recently in London than Mr. John Belcher's offices for the Chartered Accountants, in the city. As will be seen from the illustration, it exhibits a use of classic details in a remarkably bold and unconventional manner, and this novelty and independence of treatment pervades the whole building, internally and externally. This is the most note-worthy of Mr. Belcher's buildings; a book of photographic illustrations of it has been issued by Mr. Batsford, the well-known architectural publisher, and any of my readers who may procure this will, I think, agree that the illustrations represent a building of very remarkable character. All Mr. Belcher's designs are distinguished by original feeling, and his competition design for the completion of South Kensington Mu-

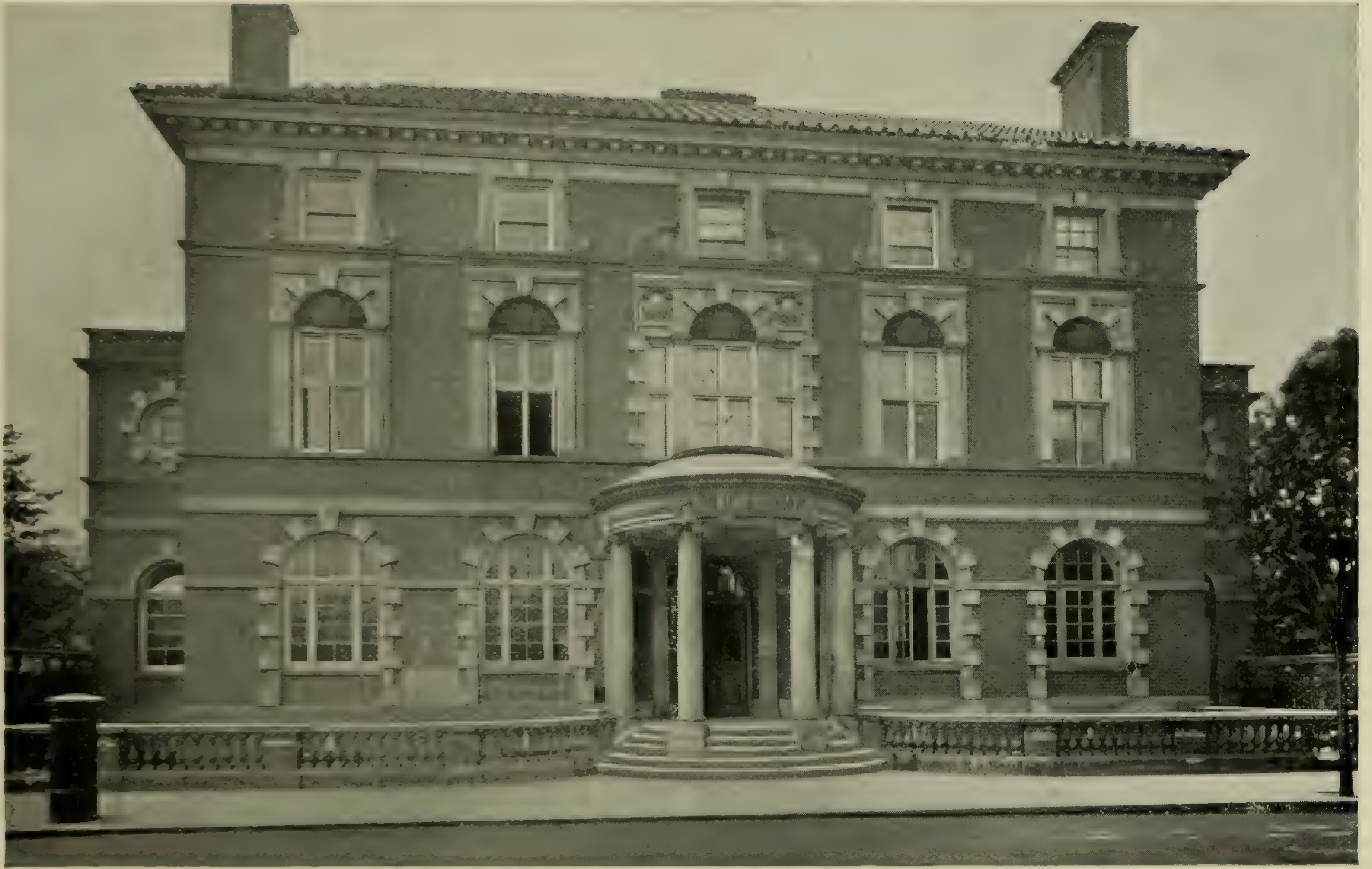


SOUTH FRONT, BATTERSEA TOWN HALL. BY MR. E. W. MOUNTFORD.

seum was a very remarkable effort, and one of the most powerful designs that has ever been submitted in a large competition.

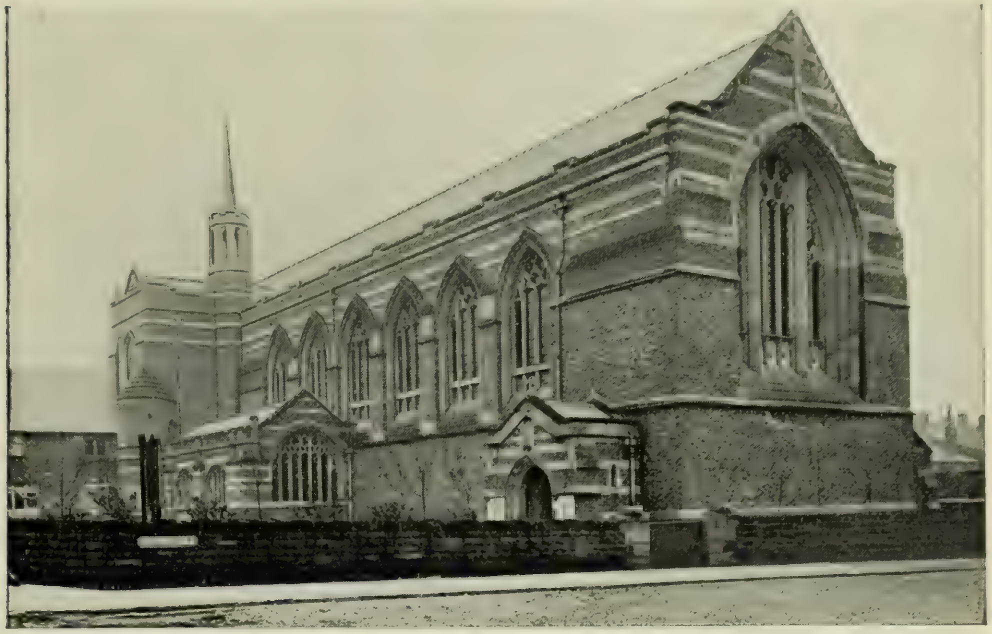
Two other architects among the neo-classics may be named who are filling a considerable space in the English architectural work of the day. Mr. J. M. Brydon came prominently into notice some years ago by his design which gained the competition for the Chelsea Town Hall, and which was the result of an obviously very careful study of the architecture of the Queen Anne and early Georgian period, and was therefore especially suitable to the locality. Since then Mr. Brydon may be said to have become generally recognized as the architect best fitted to deal with that particular phase of English architecture, and, when he gained the competition for the new Municipal Buildings at Bath, it was generally felt that no one was better qualified to produce a building in harmony with the city which bears so much of the impress of the architect who in the last century was famous as "Wood of Bath." Mr. Brydon has since gained also, with equal suitability, the competition for the extensions to the pump-room and the treatment of the ancient Roman bath in the same city. The Chelsea Public Library, with its semi-circular colonnaded portico, is a good example of his work. The Battersea Public Library, of which an illustration is also given, is one of the recent works of Mr. E. W. Mountford, who gained some years ago the competition for the Sheffield Town Hall, and has won competition after competition since. In his style as exhibited in the Sheffield building he may be said to have owed something both to Mr. Waterhouse and to Mr. Collcutt, but in more recent buildings he has adopted a treatment more decidedly his own. Mr. Mountford was for the last 2 years the president of the Architectural Association.

Church architecture is a less prominent factor at present than it was in the days of the ecclesiological revival, but the commencement of a nineteenth-century cathedral in England—*viz.*, that of Truro, of which the choir and transepts are completed—is an important event, and its architect, Mr. J. L. Pearson, R. A., is one who is to be credited with something more than merely accurate revival of Gothic. The interior of Truro choir, certainly, is the most remarkable realization of the medieval spirit in church architecture that could be seen, – far more so than any of Scott's works,—but it is not mere copying; the building has its own points, not to be found in any medieval cathedral; and in the exterior treatment, both here and in his churches at Kilburn and Red Lion square (London), Mr. Pearson has given his own peculiar stamp to revived Gothic architecture. Mr. Jas. Brooks, who recently was awarded the Royal Gold Medal of the Institute of British Architects in recognition of his works, has built,



PUBLIC LIBRARY, CHELSEA. BY MR. J. M. BRYDON.

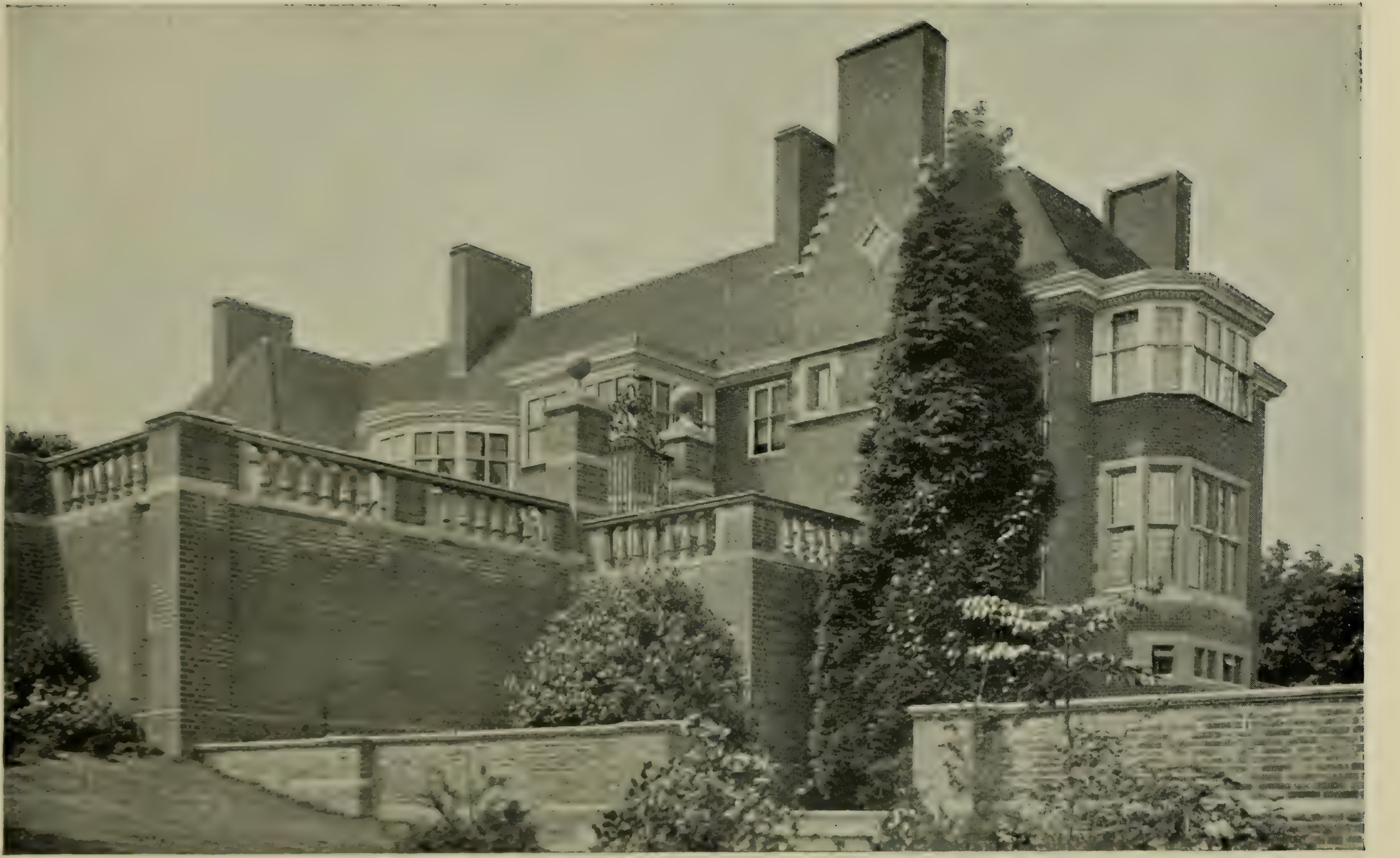
and is still building, large town churches whose plain and massive architectural treatment, mostly in a modification of early Gothic, but with a distinctly marked individual character, forms a welcome contrast to the florid modern Gothic of which we saw far too much during the earlier years of the present half-century. Mr. Leonard Stokes, an architect with a large practice among the Roman Catholic community, of which he is a member, is a true artist in architecture, whose designs always have a special interest both from their refinement of taste and from the variety of original treatment which they evince. Mr. Stokes belongs to an artistic family, his brother, Mr. Adrian Stokes, being one of the finest and most intellectual English landscape-painters of the day.



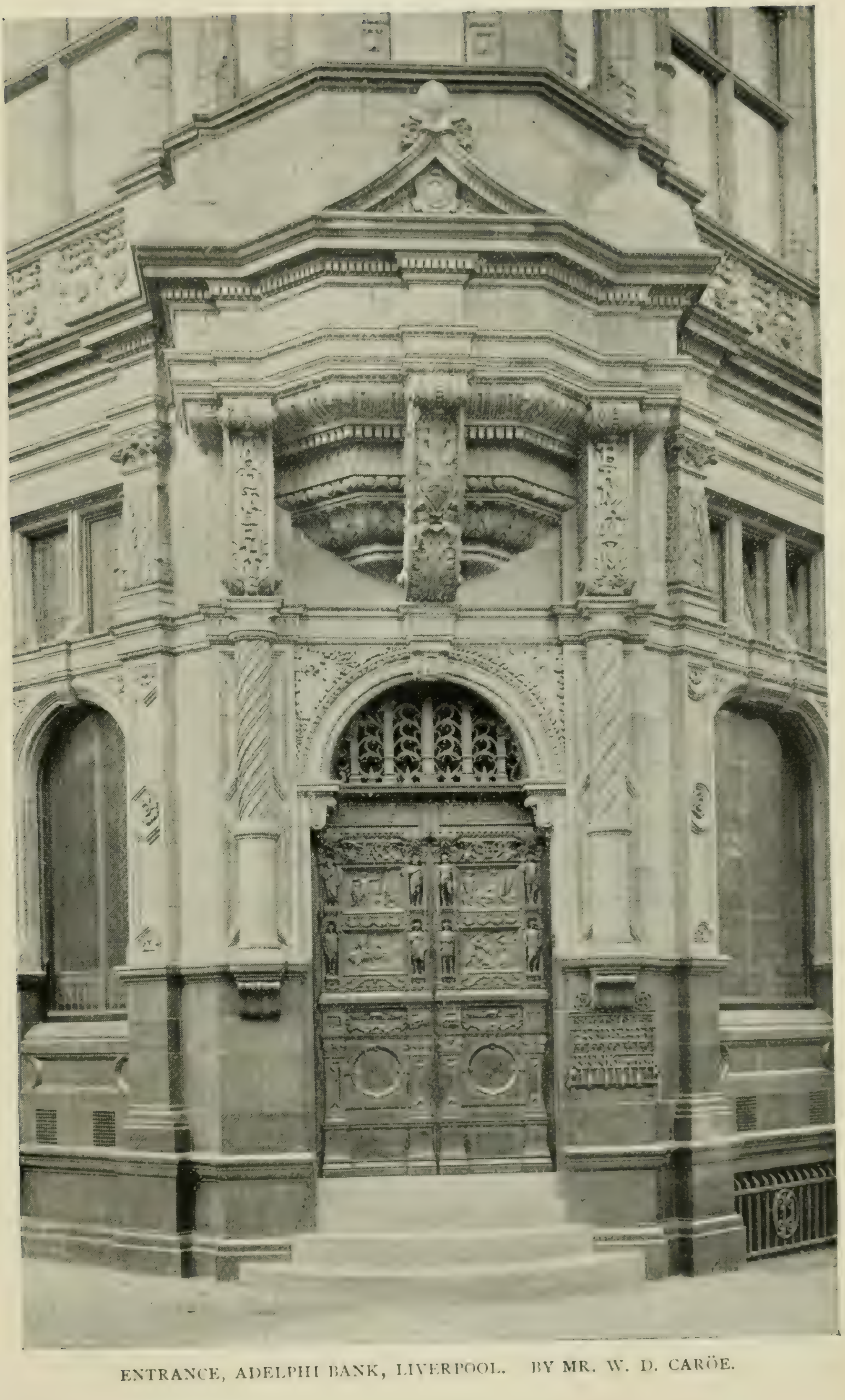
ST. CLARE'S CHURCH, SEFTON PARK, LIVERPOOL. BY MR. LEONARD STOKES.

Among the younger architects who are doing good work, and of whom more will probably be heard, is Mr. W. D. Caröe, the new president of the Architectural Association. He has carried out designs both of Gothic and of classic tendencies, and has not so far developed a distinctive style of his own, but he has always put some original treatment into the employment of traditional details. Of this his Adelphi Bank at Liverpool, one angle of which is here illustrated, is a good example. The design of the bronze doors in this building, with their series of statuettes, has been much admired.

In the production of picturesques houses of small and medium size no one has been more successful than Mr. Ernest Newton, one of the "anti-Institute" architects. The variety of his houses, both in plan



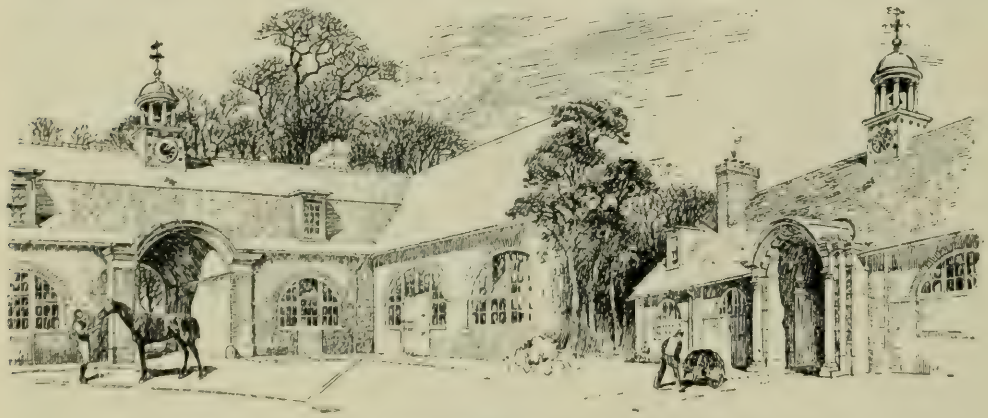
BULLERS WOOD, CHISLEHURST—KENT. BY MR. ERNEST NEWTON.



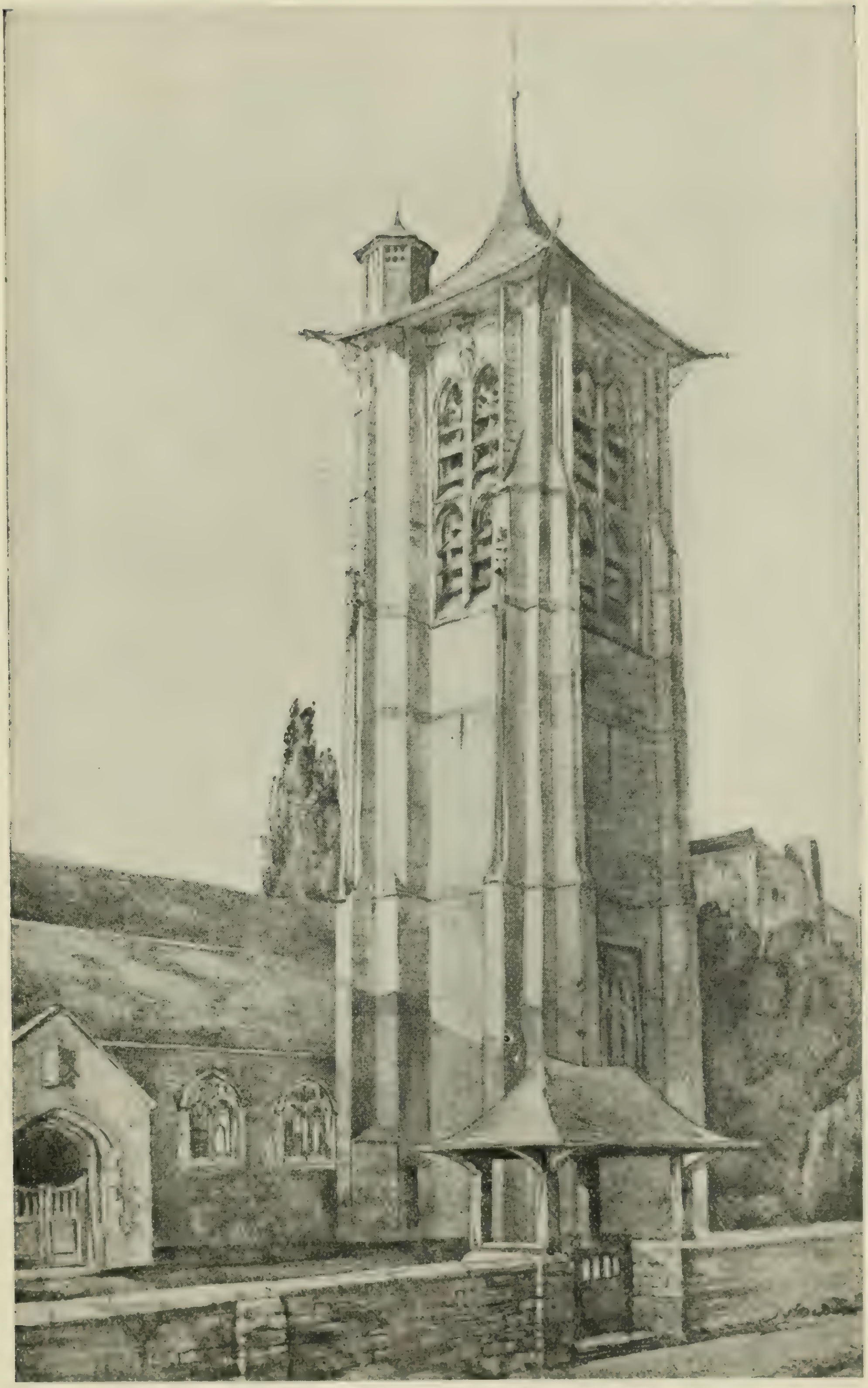
ENTRANCE, ADELPHI BANK, LIVERPOOL. BY MR. W. D. CARÖE.

and design, is remarkable ; what is more remarkable is the manner in which he contrives to give them picturesqueness of outline and effect without ever departing from simplicity. There is never any appearance of conscious striving after the picturesque, never anything vulgar or restless in appearance. If we compare his country houses with the terrible things which are shown at the French Salon under the term "maison de campagne," we can the better realize the good taste and reticence of this essentially English domestic architecture of Mr. Newton's.

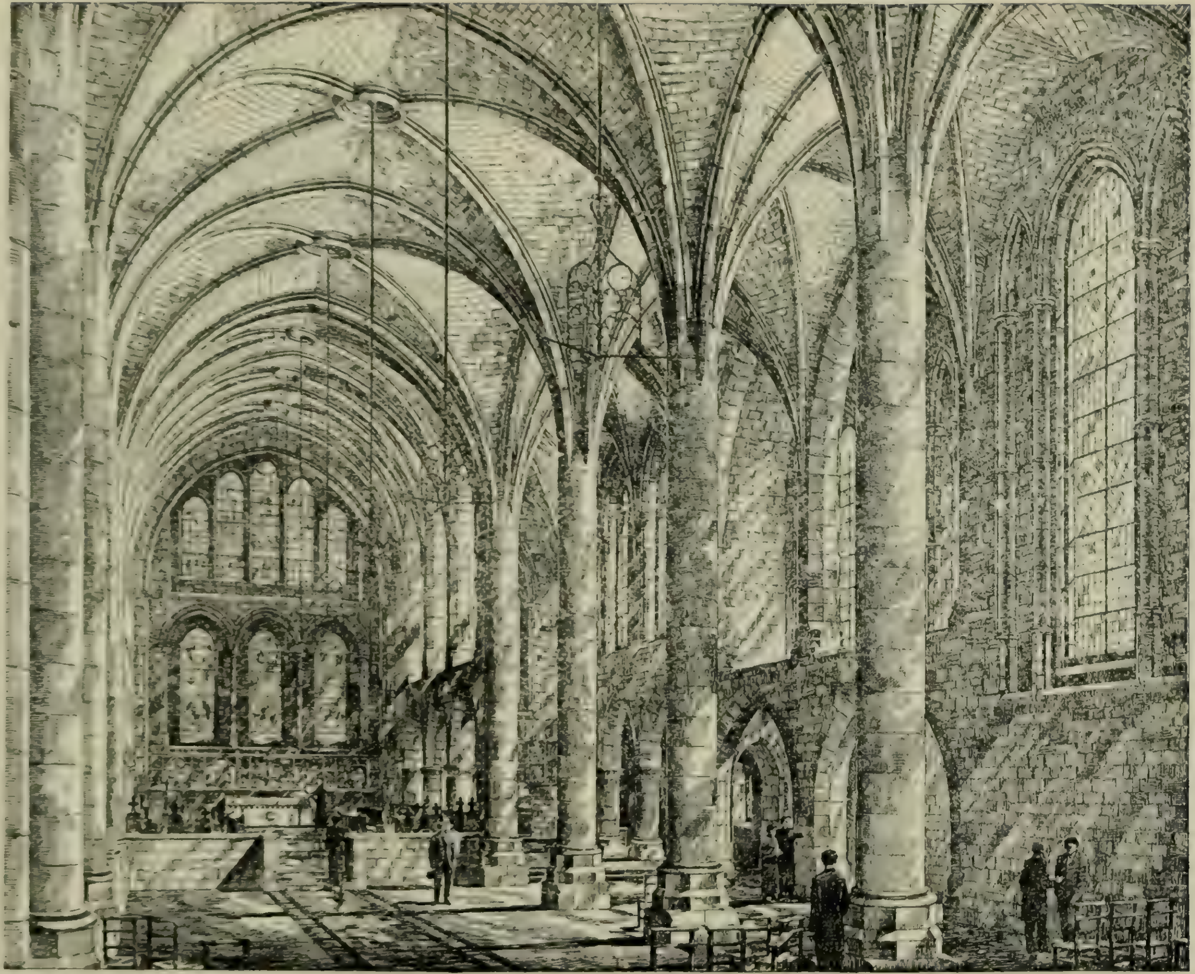
An architect who has done comparatively little actual work, and who is regarded with great esteem from a conviction as to what he could do if he had the opportunity, is Mr. Halsey Ricardo, another of the clan who stand aloof from the Institute. There is a remarkable originality about the few things he is known by. His office front in Great George street (the street of engineers), where he has transformed a common brick front into a picturesque piece of street architecture by mere treatment of the windows and doorway, is a thing that no one can pass without notice. Another architect of original genius who has done little is Mr. Lethaby, the author of a recent notable book on "St. Sophia and Byzantine building," a designer of artistic furniture, an artist and draughtsman of remarkable powers, but who lives the life rather of a student of architecture than a practitioner of the art. Among the younger men of the day who will probably be more heard of is Mr. Beresford Pite, who jumped into note as a student from a remarkable, but somewhat *outré*, drawing, with which he gained the Soane medallion at the Institute of Architects about a dozen years ago, and was for some time known as a powerful draughtsman with a great fondness for medieval and Albrecht Dürer-ish effects, but is now showing that he adds to the eye of an architectural artist the practical insight of an architect. Mr. G. C. Hersley, a pupil (like Mr. Lethaby)



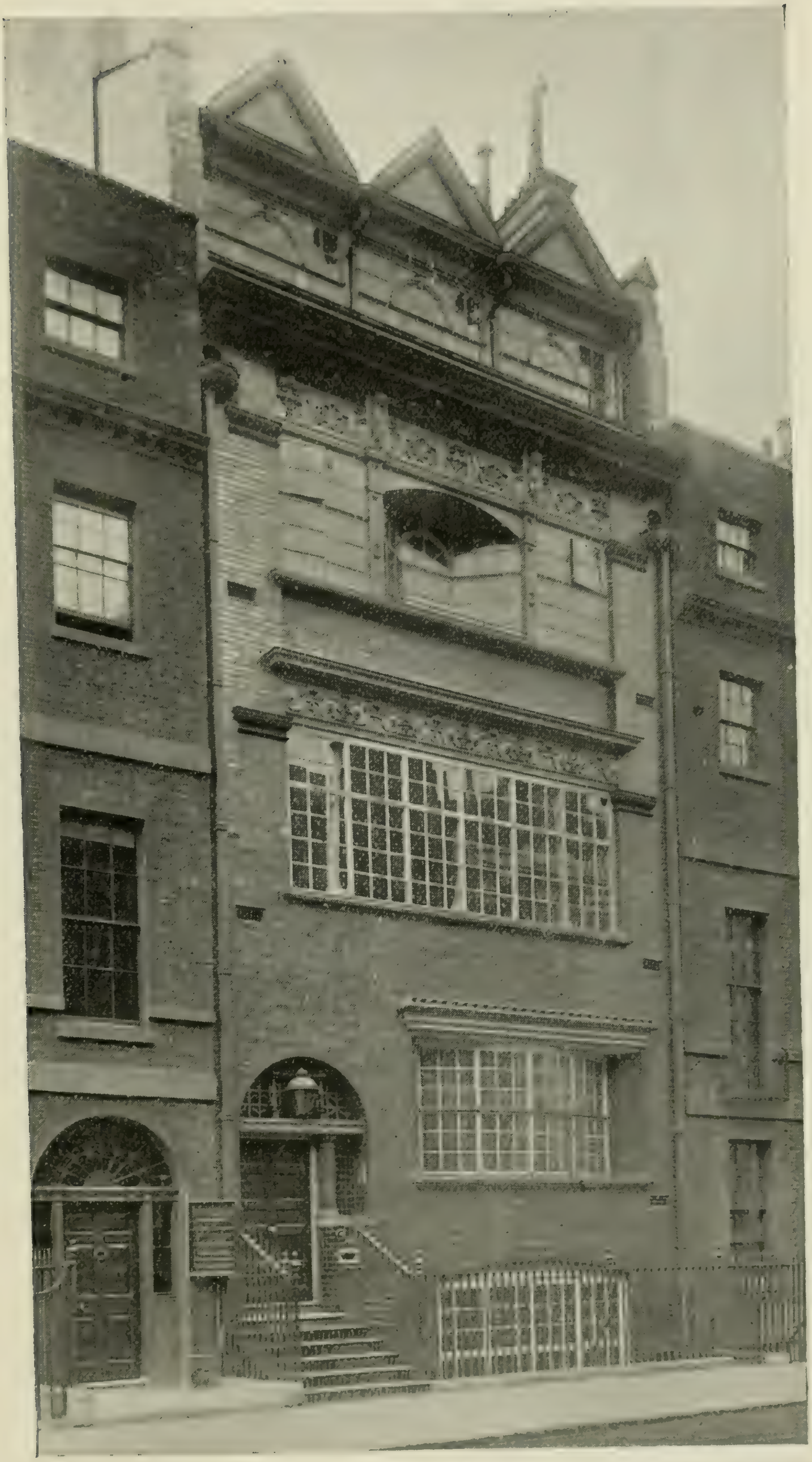
STABLES, BECKLEY HALL,—KENT. BY MR. ERNEST NEWTON.



NEW TOWER, ST. MARY'S CHURCH, LYNTON. BY MR. H. WILSON.



CHURCH OF ALL HALLOWS, GOSPEL OAK, NEAR LONDON. BY MR. JAMES BROOKS.



FRONT OF OFFICES, GREAT GEORGE ST., REMODELLED FROM A PLAIN BRICK FRONT. BY MR. HALSEY RICARDO.

of Mr. Norman Shaw, is another beautiful draughtsman, who has made some very original designs, and who, if he develops a larger practice, will certainly produce buildings in which the art of architectural design will be worthily illustrated.

One more very clever architect must be mentioned among the younger generation, Mr. H. Wilson, formerly assistant to the late J. D. Sedding, and on whom the mantle and the practice of that talented architect has fallen. Mr. Wilson occupies a place entirely apart, having an almost visionary and utopian ambition to throw aside all precedent in architecture, and to produce buildings which are absolutely new in treatment. This, no doubt, has led him into a good deal of eccentricity, but it must be admitted that he has actually realized a remarkable originality in some of his designs, and, being possessed of exceptional powers as a water-color artist (at all events, in the treatment of architectural subjects), he is able to illustrate his own designs in a most effective manner, and his drawings are usually among the most striking and prominent exhibits in the architectural room at the Royal Academy.

The few illustrations which accompany this article serve only to give a very inadequate idea of the amount and variety of good, interesting, and refined architecture which is being produced by the best English contemporary architects. A more extended illustration would, I think, fully bear out what I have tried to impress on American readers in this article,—that, although the French may be superior to us in the grandiose treatment of large city buildings of more or less classic type, the English architecture of to-day is not inferior to that of any nation in the world in point of variety, picturesqueness, and refined taste, and that American students of architecture would do well to give it a little more of the attention which they at present seem disposed to bestow almost exclusively on Paris and the École des Beaux Arts.

THE PREVAILING SCARCITY OF SKILLED LABOR.

By A. E. Outerbridge, Jr.

> Some one has well said that the tragedy of to-day is not the tragedy of the criminal, but of the incompetent, and not of the absolutely incompetent, but of the relatively incompetent. It is the tragedy of the man who has the best intentions and the best character and a fair equipment for his work, but who has not a thorough equipment, and who can not do the thing he starts to do in the best possible way. Society is crowded with half-equipped workers, with men and women who are honest and earnest and not incapable, but who are not up to the level of the very best work. It is amazing, in view of the immense number of those who are seeking for positions, how few persons there are competent to fill any particular position. To fill a position of any importance requires often most diligent searching in many directions. There is a host of fairly well-equipped people, but there seems to be, at the moment when they are needed, few perfectly-equipped persons. When one has a piece of work to be done, it is easy to get it fairly well done, but it is extremely difficult to get it thoroughly well done. This is true of all grades of labor. . . . In spite of the terrible need of work which weighs upon the masses of men, and in spite of the superior processes of education which are offered to the fortunate few, it remains true that society is filled with incapable or only partially-trained people, and that, when the thoroughly-trained man or woman, perfectly fitted to do a specific thing in a superior way, is needed, a candle must be lighted and a long search begun. The great lesson to be read to boys and girls to-day is the need of some kind of absolute competency, some kind of ultimate superiority.—*The Outlook.*

A RECENT advertisement for a "handy man" to fill the humble position of porter in a store resulted in blocking the highway with applicants, so that it became necessary to call a policeman to compel the men to form in line. Nearly all trades, not to mention one or two learned professions, were represented. At the same time the mechanical papers were calling attention in editorials and news items to the scarcity of skilled labor which has been observed since the revival of manufacturing business. What is the explanation of this anomalous or contradictory condition of affairs? It has been noted that, instead of a plethora of skilled labor seeking to take advantage of the newly-presented opportunities for remunerative employment, there is, in some trades, a prospective, if not already an actual, scarcity of such labor. It is surprising that a complete reversal of conditions should have occurred in so short a time, and various theories, more or less plausible, have been advanced to account for this change. It is explained, in a vague way, that the best men have drifted into "other occupations"; but, as it is a law of nature that two things cannot exist in the same place at the same time and two persons cannot fill the same position, this is no explanation, but a mere begging of the question.

We must either assume that one class of labor has been displaced by another class,—in which case there would still be a surplus of the unemployed,—or else that there has been a phenomenal enlargement of the field of occupations requiring skill. Everyone believes that there has been a large expansion and wide opening of new fields of labor through the aid of invention within a very few years, and especially in the domain of application of electricity to utilitarian purposes great activity now prevails; but, until this high pressure assumes a somewhat fixed point, and sufficient time has elapsed for the gathering of census returns, the ultimate effect of such new undertakings in affecting the labor market and in explaining the scarcity of skilled labor must necessarily be largely conjectural.

One fact, however, stands out prominently in this field of observation,—*viz.*, that the hysterical outcry of the Socialistic agitator (often echoed by misinformed, though well-meaning, philanthropists and theorists) that the introduction of labor-saving machinery would necessarily produce a permanent glut in the labor market is disproved by the present state of things.

No sooner have the wheels of industry commenced to revolve than it is found that the proportionate number of available skilled operatives has not kept pace with the increased number of mechanical appliances requiring such attention. In other words, the ratio of intellectual force to mechanical power formerly existing in the world has been changed through invention, and the equilibrium disturbed.

Every new machine put into operation demands at least occasional attention of skilled human labor. Each new invention widens the scope of human industry, opening up new sources of production and new outlets for consumption of manufactured products.

As new machines can be produced more rapidly than skilled operatives can be created, the balance between human skill to direct and mechanical power to execute,—between mental force and mechanical force,—heretofore existing, has been overturned, and, instead of a surplus of skilled labor crowded out by labor-saving machines, we find an opposite condition existing to-day. The demand for the modicum of skilled labor which the operation of all machines admittedly requires is greater than the supply, and to this cause I believe we may partly attribute the scarcity of skilled operatives which has been noted in some trades, especially those in which labor-saving machinery has been highly developed.

There are other causes operating to produce the same result, but I have endeavored to formulate one theory which has perhaps been hitherto overlooked. It will seem, no doubt, a contradictory and perhaps absurd statement to many readers that every new labor-saving invention increases the field for employment of skilled labor, but this anomalous proposition is advanced, not merely as a startling or a brilliant theory, but as a fact which has been demonstrated many times, as in the case of the sewing machine and other mechanical inventions. The statistics furnished by the Labor Bureau in Washington, though carefully shunned by many intelligent readers, afford a fund of surprising information, often upsetting the prognostications of theorists. Citations can be given *ad libitum* showing that, in many branches of industry in which the saving of labor has been most thoroughly accomplished, work is given to a much greater number of employees than could have been utilized without the increased business resulting directly from the decreased cost of production. "Everybody knows that ingenious machinery well nigh destroyed the once intricate trade of the carpenter, so that only the simplest operations remain to utilize manual labor. But the effect of this has been to increase the number of carpenters, not to diminish the demand. The ten years between 1880 and 1890 witnessed the introduction of many highly-efficient machines, by which hand labor was still further dispensed with; but, nevertheless, there were 140,021 carpenters in this country in 1890 against only 53,547 in 1880, and the average annual earnings in 1890 were $675 against $450 in 1880. Machinery for handling clay and molding bricks has made tremendous inroads upon hand labor during recent years; yet from 1880 to 1890 the number of persons employed in brick and tile making increased from 59,032 to 109,151, although the number of establishments increased only from 5631 to 5828 in the same period of time. . . . In few industries has the saving of labor by machinery been more marked than in the manufacture of furniture, and the cheapening of the product has been amazing. Yet this industry gave employment to 92,504 persons in 1890, as compared with 55,464 in 1880, and in the same period the average annual earnings of the employees advanced from $453 to $527.*

Such facts are irrefutable arguments, which agitators fear as greatly as dilettanti abhor. From a recent editorial discussion in the *Iron Age* concerning the scarcity of skilled workmen I quote as follows:

> It now appears to be absolutely necessary to devise further means of conducting manufacturing operations by labor-saving machinery, if the supply of workmen cannot in some way be augmented. Not only are skilled workmen scarce, but an absolute dearth exists of thoroughly-qualified experts to direct department work in large manufacturing establishments. Our mechanical progress appears to be developing at a rate of speed out of proportion to the conventional methods of preparing men to fill the exacting duties now required of them. Within the past few years new industries have grown at a marvelous rate, which have made heavy drafts on the ranks of those who either were, or were apparently destined to become, leaders in the older industries.

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* From an editorial in "The Philadelphia Record."

Opportunities for more rapid advancement or for better financial returns have been seen in the electrical business, in the tin-plate trade, or in the manufacture of bicycles, or in some other comparatively new line. Again, the growth of old works has advanced men of ability in department work to positions of more general supervision, and vacancies have thus been created which are hard to fill.

With respect to the extent of the new and rapidly-increasing industry specified in the foregoing editorial,—*viz.*, the bicycle manufacture, —readers of the ENGINEERING MAGAZINE will recall a carefully-written and illustrated article in the issue for May, 1895, by Mr. Robert Perkins on this "Marvel of Mechanical Achievement." Mr. Perkins, who has been associated with the bicycle industry from its commencement in this country, states that he first saw a bicycle in 1869, and bought one in 1870 which weighed 116 lbs. At the cycle show in January, 1895, he saw a ridable machine weighing only 8¾ lbs., which safely carried a 160-lb. man on a floor, and he adds that, even at the roadster weight of 22 or 24 lbs., the cycle carries a greater load with safety than has ever been put on any other vehicle. After the temporary phase of the "high ordinary" had died out, the revival of the cycle in the United States began about 1882, but did not reach a popular craze until about 1890, since which time the revival has progressed with wonderful rapidity, which the hard times has never checked.

In England the present Coventry cycle industry employs about fifteen thousand hands in forty workshops. Mr. Perkins, in his article, estimated the output for 1895 in the United States at four hundred thousand wheels, and it is a well-known fact that it was not until last September that the majority of large manufacturers were able to catch up to their orders, from which fact it may be inferred that Mr. Perkins's estimate was below rather than above the mark. The average of a number of estimates based on figures obtained within a month gives the probable output for 1895 at 750,000 wheels. Statistics are not at hand to show the amount of capital invested and the number of skilled hands employed in this manufacture. Mr. Perkins hazarded the statement that perhaps a hundred millions of capital is employed in this industry in the United States alone, and recent announcements in the bicycle trade journals state that new capital has been enlisted to produce an enormously increased output of bicycles for 1896 at a great decrease of price.

To the labor employed in the direct manufacture of the bicycle proper, must be added that involved in the separate manufacture of adjuncts, such as rubber pneumatic tires, saddles, cyclometers, pedals, lamps, and the numerous articles known to the trade under the head of bicycle sundries, to the making of many of which separate manufactories are devoted. The impetus which this industry has given to invention and improvement in the manufacture of cold-drawn light steel tubing, brazing, enamelling, nickel plating, and the manufacture of laminated wood rims has been comparatively recently demonstrated in a series of illustrated articles in the *Scientific American.* The use of this vehicle, not only as an instrument of recreation and sport, but as the business man's carrier, is not confined to the cities, but has penetrated even country districts throughout the entire United States, and the summer traveller is now surprised to find a high-grade wheel at almost every cottage in the villages. The necessity in many cases of being able to adjust and repair one's own machine is proving a silent mechanical instructor to many thousands of riders.

It is safe to assume that the near future has in store many new developments, such as a special package-delivery wheel, changeable gearing, motor wheels, &c., which will still further add to the natural increase in the manufacture and use of this wonderful machine. One of the illustrations in Mr. Perkins's article shows a large number of women employed in one or more of the departments of manufacture.

Some idea of the perfection of mechanical appliances used in the manufacture of bicycles may be gained from the fact that a large concern recently installed a hydraulic testing machine of the latest "Emery" design, having a capacity of 100,000 lbs., and has an equipment of tools equal to that of the finest government armories, while many elaborate special tools have been devised for this work.

Recent indications point to the probable development in the near future of the "Horseless Vehicle,"—a field which is at present unoccupied and almost unlimited. The successful long-distance trials of such conveyances in France (covering more than 700 miles in 2 days) have attracted world-wide attention, and American ingenuity is already at work upon the problem ; even before the foreign tests were made, a carriage propelled by storage batteries was a familiar object on the streets of Philadelphia.

With the improvement of common roads, due in large measure to the influence of bicyclists, and the daily evidence afforded of the immense gain in speed and comfort of suburban travel by the substitution of electric trolleys for horses, it would seem natural to look for the general introduction of self-propelling vehicles ; this would mean new employment for millions of capital and thousands of men.

It is but a few years since the first electric trolley street car line was established in Richmond, Va.; the comparatively small capital required was raised with difficulty, and so primitive were the appliances that for a few months it was not regarded seriously. It was customary on the approach of a storm to cut off all connection between the dynamos and trolley wire, tying up the cars and compelling the passengers to walk home. A very few years ago a dynamo having an equivalent of 50 h. p. was christened a "Jumbo." Now dynamos of 5000 h. p. have been installed at Niagara Falls.

The trolley system, having spread a net work of wires like spiders' webs through every town of any importance, is now reaching out its feelers to connect the neighboring villages, and eventually to form trunk lines. Already announcements are made of business amalgamation of great manufacturers of electric and of locomotive machinery to exploit this promising field.

The guesses regarding the amount of capital invested and skilled labor employed in the development and manufacture of electrical appliances used in the trolley lines and for their equipment, and continuous operation, day and night, which sounded fairy-like when first announced, soon faded into insignificance when submitted to actual proofs.

The field of electric lighting alone, irrespective of power distribution, has grown to gigantic proportions, and, as statistics are now being gathered to exhibit these various new industries in their true proportions, it would be unwise to anticipate the publication of reliable facts by further guesses at this time.

A comparatively new industry which has sprung into importance within a few years, of the delicate nature of which the public has little conception, is the manufacture of the Welsbach incandescent filament for gas burners. Millions of these delicate filaments are now in practical use, and their manufacture, in which women are mainly employed, implies a high degree of skill. A new rival to the Welsbach light and the incandescent electric light has also recently appeared upon the scene in the form of the old and well-known acetylene gas, produced, however, by a new and cheap electrical process. Capital to a large amount has been attracted to the development of this discovery, and a new industry is apparently about to be created, the possible extent of which it is difficult to anticipate.

The improvements in the manufacture, and reduction in cost, of structural iron, following rapidly upon the modern practice of constructing "sky-scraper" buildings, some of them twenty stories in height, from a skeleton framework of iron, has practically developed a new industry of large magnitude. The utilization of rolled iron and steel for many other new purposes will no doubt still further enlarge this important branch of labor.

The manufacture of tin plate, which was commenced on a practical scale only a few years ago in this country, has thrived in spite of hard times and adverse tinkering of the tariff, so that the largest tin-plate mills in the world are now located in America, and turning out finer tin plate by automatic machinery than was formerly produced in Wales by hand manipulation, the machinery being of recent American invention. The number of novel minor manufacturing industries which have originated in this country during the past decade is almost without limit, and in the aggregate they afford employment to armies of skilled operatives; among these, cash registers and cigarette machines are perhaps most remarkable. The chief examiner of the patent office recently stated that "the cash register has already put upon the market $15,000,000 or $20,000,000 worth of material, the cost of which is mainly labor."

A century ago hand-made watches were so costly that only wealthy people possessed them; the laboring classes depended on the town crier and the village clock. Now, the daily output of cheap but good machine-made watches from one factory in New England, is said to exceed the yearly production of the world a hundred years ago. Be this as it may, the number of hands employed in making watch-making machinery far exceeds the total number of watchmakers before the invention of such machines.

In order to study our question with the hope of arriving at some understanding of the causes leading to this state of affairs, we should look first at the most obvious changes which have recently occurred in methods of conducting industrial works. Formerly master workmen were, as a rule, graduated apprentices, but the apprenticeship system has been gradually dying out in this country, and the reasons therefor are not hard to find. They may be classed under three heads.

First: The objection of the youth of to-day to binding himself to learn a trade, as was the custom of his forefathers.

Second: The restrictions put upon the apprenticeship system by labor unions.

Third: The modern "piece-work" system.

I find, upon inquiry among the working classes, many reasons given in explanation of the disinclination of boys to indenture themselves to-day, the most frequent and important being the competition of labor-saving machinery. For example, in iron foundries small miscellaneous castings which are easily molded and require but little finishing were formerly made by boys, who soon became expert; an active, intelligent boy was able, in many cases, to make good wages long before the expiration of his indenture. Work of this kind is now generally made by molding machines, and I admit that the molding machine operates to the disadvantage of the apprentice. One molding machine will turn out more and better work per day than could be produced by the usual number of apprentice boys which a foundry could economically employ.

The intelligent boy who desires to acquire both theoretical and practical knowledge now prefers to enter the admirable industrial schools which are available in many of the larger cities ; the number of such schools, however, is, as yet, too small to provide facilities for more than a small fraction of one per cent. of the American youth. The work that these schools is accomplishing is of the highest order ; in fact, they are turning out a better class of graduates than was anticipated, and in this respect they are over-reaching the mark aimed at, which was to produce bright young workmen, not engineers ; men, not officers.

The arbitrary limiting of the number of apprentices in shops by trade unions was one of the short-sighted regulations made by that remnant of an old school of handicraftsmen, and is (in those occupations with which I am familiar) practically a dead letter.

The " piece-work system," which is superseding the old custom of paying workmen by time, or " day's wages," although stimulating the skilled hand to do more work and thus to receive more pay, incidentally operates against the employment of apprentices.

The skilled workman who has contracted to finish a certain "job" for a given price can not spare the time to assist a tyro. The apprentice is thus handicapped by such inventions as the molding machine at the bottom, and by the piece-work system at the top. The piece-work system is destined, I believe, to practically supersede time wages. Somewhat similar conditions confront the apprentice in the machine shop, and in fact in many other branches of industry. As the old system is thus clearly doomed, the wisdom of extensively enlarging the manual training school—not as a mere adjunct to the public school system, but as a distinct and important feature thereof—would seem to be clearly indicated, and it is hoped that the arguments here offered may emphasize this necessity of the times.

During the late period of depression, especially in the older established lines of manufacture, very many of the skilled workmen drifted gradually away from their former occupations into these younger and more active fields of labor, and, now that they are again required, are not available. This experience will prove a sober lesson to those employers who, from a short-sighted policy or economy, permitted their skilled operatives to depart on slight pretext ; and those, on the other hand (of whom there are many), who suffered actual losses rather than lose their skilled hands will now reap the benefit, not only in having facilities for prompt execution of orders, but in retaining the *entente cordiale* of their employees, which is an important item in economic administration. There is no service like willing and interested service.

One of the largest manufacturers in the world said not long ago in reference to this matter : " It is simply impossible to put new men into the places of our trained workmen, for it takes years to learn the business. Throughout my whole business career I have made it a rule to stand by my trained workmen to the last limit of endurance ; and, whenever we had a difference, and I felt myself to be right in the position I took, I simply shut down the works until they came to my point of view." This is a correct principle upon which to conduct a manufacturing establishment, and, if generally followed, would soon become an established custom.

The introduction of labor-saving machinery has enormously increased the output for each workman, and this introduces a new element into the ethics of the question of wages, and also into the practical question of cost. If it can be shown that a skilled workman, at a slight increase of labor and attention, can enormously increase the output of a machine, he should be encouraged to make the effort by an increase of pay ; an increase of output must logically and necessarily involve a corresponding and fair increase in wages. Hence increase of output necessitates increase of wages, and in a properly-conducted business this increase of wages, following increased output, must mean increased profit. This is a profit-sharing scheme to which there can be no practical objection.

The conclusions to which the foregoing arguments clearly lead are : that high wages and intelligent service are to be preferred to low wages and ignorant labor ; that the introduction of labor-saving machinery, instead of supplanting human skilled labor, has increased the demand ; that the more highly developed the machine becomes, the more highly skilled the operative must become ; that there is an ever increasing demand for skilled labor of the highest class and a constantly decreasing chance for mediocrity to find employment ; and that this supply must come, not, as heretofore, mainly from training boys in factories, but from the enlargement of manual training schools, whose teachers shall be practical graduates from the factories.

The introduction of machinery in place of hand labor in manufactures is thus shown, from whatever point of view it is studied, to be mutually beneficial to the employer, the employee, and the consumer,—that is, mankind in general.

THE DISTRIBUTION OF POWER IN COLLIERIES.

By Llewelyn B. Atkinson.

THE present position of the coal-mining industry in the United Kingdom is one deserving of the most thoughtful consideration by all who are interested in the future of the commerce of the country, and the object of the present paper is to point out how, possibly, some of the difficulties under which this industry at present labors may be met. The difficulty to be contended with may be briefly stated. The possible output, and, indeed, the output at which a reasonable profit can be earned, is greater than the demand at present prices; and even this demand is threatened by the decreasing price of coal raised in other countries. From whatever point of view it is looked at, this question resolves itself into stimulating demand, which can be effectually done only by lowering the selling price, and this cannot at present be done without extinguishing the profit. To decrease the cost at the collieries, there are broadly three courses: (1) to decrease the payment per ton to the mineral owner; (2) to decrease the wages cost per ton raised; (3) to decrease the fuel expenditure per ton raised. The first of these is a matter outside the scope of this paper, the second will be briefly touched upon, and the third will be dealt with in some detail.

In the course of the last 8 or 9 years, the author has been in close contact with mining operations in various parts of England and Wales, and the opinion has gradually been forced upon him that there is a very large margin of economy in wages and fuel to be effected. This arises from the fact that economies in labor and fuel which are studied and made use of in engineering and manufacturing industries are hardly considered in coal mining, at all events in the majority of instances. This broad fact must appeal to every mind,—that, whereas in almost every manufacturing process, or industrial operation, the product per man has probably doubled and the consumption of fuel been halved within the last 15 years, in coal mining the product per man has been practically stationary, and the cost of fuel per ton raised probably nearly so. This is frequently attributed to the stringency of mining legislation, but legislation has also largely affected other industries, and the result cannot be altogether attributed to this cause. It would be a long task to enumerate the causes which, in the author's opinion, contribute to this result; but, broadly, it appears to him that what is required is to do in mining what has been done in every other department of industry,—lower the cost of wages and material per ton by increasing the product per man and per pound of fuel by the following means: (1) improved organization, both in the working, and more especially in the original laying-out of the scheme of working a colliery, and in the means for doing it; (2) more superintendence and supervision underground by thoroughly well-informed mining and mechanical engineers; (3) the greater use of mechanical power instead of human and horse labor, and more economical production of that power. In short, substitute brains and mechanical power for human labor.

It has been already stated that the immediate object of this paper is to deal with the question of the economical production of power, but a few remarks on the subject of mechanical power in collieries may be useful. The getting of coal resolves itself into cutting and filling and hauling to the pit bottom. In the great majority of collieries both cutting and filling are done without any use of mechanical power whatever, and the progress made in introducing mechanical coal-cutters is slow, at all events in this country. A considerable experience, extending over some years, with coal-cutting machines in various collieries and various parts of the country justifies the author in saying that there are hardly any seams under 3 ft. 6 in. in thickness that could not be more cheaply worked by mechanical coal-cutters than by hand labor, and with a better product of round coal, but that in probably not 5 per cent. of the collieries of the country is the existing organization of the filling and haulage sufficiently good to enable machines to be worked with that regularity which will make them pay. This is the secret of the otherwise unexplained fact that some few collieries have been and are worked by machinery with marked success, whilst the reverse holds good of the majority of cases in which it has been tried. Organization and superintendence, those are the only secrets of cutting coal by machinery; till they are forthcoming, mechanical assistance in this direction must be postponed. In thin seams much might, no doubt, be done to apply mechanical power to reduce labor and breakage in filling the coal, but the same remark applies as to coal-cutting. The use of machinery in the coal face would so much reduce the length of face under work for a given output that the roads on to the face—being less in total length—could, without increased cost, be kept in a condition enabling mechanical haulage to be used right up to the face, doing away with horses and ponies altogether. These are some of the directions in which mechanical power may be looked for to profitably enable the output per man to be increased. But before this can be done much will have to be done to improve the general organization both above and below ground. And this may well be commenced by the economical laying out and conduct of the arrangements for the generation of power above ground. Consider the conditions under which this is at present carried out.

Generally speaking, when sinking operations are completed, a winding engine is put down. Subsequently, as the workings extend, haulage is considered, and some plant—either steam, compressed air, or electrical—is provided for this. Later perhaps pumping becomes necessary, and again a plant perhaps on another system is put in. There are various engines at the surface for the screening, repairing shop, and other purposes. All these are of uneconomical types ; so there ensues, at every point, waste of heat and waste of steam, particularly when, as in some cases, separate boilers are put down for each plant. And the answer to any criticism generally takes the form: "Oh, fuel is so cheap at a colliery that it does not matter." Why is the fuel so cheap,—that is, of such low value? Because it is so small —smashed in hewing, smashed in filling, smashed on the screens, due to imperfect methods and appliances at every point. But, at any rate, it is worth at least 2s. 6d. per ton, and it is estimated that from 5 per cent. up to even 10 per cent. of the total output by weight of the collieries is consumed at the surface, and this means, even taking the lower figure, about 9,500,000 tons, worth about £1,190,000 per annum. It has been stated by Mr. Forster Brown that the probable consumption of coal in colliery engines, taking an average, would be not less than 6 lbs. per horse-power hour. Taking this to refer to indicated horse-power, it is possible to produce the same power with 1½ lbs. of coal, or even less ; hence it may be fairly said that there is a possible saving to be effected of 75 per cent., worth annually nearly £900,000. It would probably be well within the mark to say that the saving to be effected in labor of handling, and in the maintenance of boilers and appliances for consuming this, would be worth, say, 65 per cent. of the above sum, showing a possible economy of, say, £1,500,000 per annum, a sum equal to over 2 per cent. on the total value of the coal raised, or about 3¾ per cent. of the whole wages annually paid in the mining industries ; and, if the coal were raised unbroken, so that its value was equal to the average value of the coal sold, these figures would rise to 3 per cent. of the value of the total coal raised, or 6 per cent. of the wages paid. It may be stated at once that, to realize these economies, the power required must be produced by compound or triple expansion condensing engines, appliances almost unknown in colliery work, and to do this there is no doubt that the question resolves itself into the production of the whole power required at the colliery in one or at most two engines, and its distribution with as little loss as possible to the points where power is required. There are various methods of distributing power, but some of them are applicable only to particular cases, or in particular circumstances ; the only two of general applicability are compressed air and electricity. Of these, while under favorable circumstances compressed air can be made to give a favorable efficiency, its application in mining is discounted by two important considerations of economy. To utilize compressed air with efficiency (1) the pipes must be free from leakage, (2) the air must be heated before being used. These two conditions are practically unrealizable, and hence the efficiency of air transmission in collieries is, and must necessarily be, low. The cost of plant and extended air-mains is also high. There is an advantage in compressed air that to some extent it admits of storage, and therefore the power-producing plant may be fully loaded, producing the average requirement, which, as will be presently shown, is considerably less than the maximum. With this one exception of storage, the advantage in point of view of efficiency as a means of distributing electric-motive power remains with electricity ; and the economy of the cables compared with air mains, and the facility for extension and alterations in the position of the machinery, make electricity an ideal means of distributing power.

There is, however, an objection to which I must refer,—*viz.*, the question of safety. This question of safety is one which, from the first introduction of electricity in mining, has been prominently before engineers ; but it may be noted that among those who have had practical experience of its use in mines the objection is rarely raised. In a paper read in 1891 before the Institution of Civil Engineers by the author, in conjunction with Mr. C. W. Atkinson, this question was somewhat fully dealt with, and certain conclusions were arrived at which time and experience have gone to prove the correctness of; but, as this question is to some minds still an open one, and as additional experience has added to the knowledge of the subject, it may be well to deal with it at some length. There are two distinct questions : (1) the safety of an electric motor, which may spark at the commutator ; (2) the safety of a system of cables, which may be ruptured while carrying an electric current.

Dealing with the first of these, it has been shown from various considerations and by practical tests that with the amount of sparking which exists with electric motors of good construction it is impossible to ignite firedamp, owing to the fact that the temperature is never sufficiently high, and it is only therefore in exceptionally abnormal circumstances, such as a brush falling out of its holder, or becoming displaced absolutely on the commutator, that the inflammation of firedamp can be effected ; and it has also been shown conclusively by experiment that there are in the market methods of enclosing either the whole machine, or the armature and commutator, or the commutator alone, which, even under these abnormal circumstances, entirely prevent either the access of firedamp or the ignition of firedamp outside the machine. Practical experience is in accord with experiment and with the principles named, and the author knows of no recorded instance where there has been any accident from the use of an electric motor in a coal mine. As regards the second point in the question of safety,—*viz.*, the possible breakage of a cable,—this may be at once overcome if the cables are buried below the surface ; but, as this method has the disadvantage of expense, and frequently of deterioration of the cable, we may consider the case of a cable hung from the walls or timbers. In this case, if the cable does break, the ends are quickly parted ; the spark may continue for the fraction of a second, but it has been shown by the experiments of Messrs. Wüllner and Lehmann, at Aix-la-Chapelle, which experiments were accepted by the Prussian Firedamp Commission, "that even violent sparks from rupture of the current, accompanied with the explosion of fragments of iron in a state of combustion, had no effect on the inflammation of firedamp."

Considerable light has, in the author's opinion, been thrown on this question by the facts recently stated by Professor Vivian B. Lewes. It appears that the ignition of firedamp arises in most cases, not from the raising of the temperature to the ignition point of firedamp, which is very high, but by the raising of it to the point of its decomposition with evolution of hydrogen, which, becoming ignited, eventually ignites the firedamp. This requires two things: (1) Time (and Professor V. Lewes states that 10 seconds is in some cases necessary) ; (2) the maintaining of a particular mass of gas in contact with the point where the heat is developed long enough to effect the operation quoted. Neither at the commutator of a motor, or in the case of a ruptured cable, are these conditions fulfilled. In the face of the facts and experiments and experience now at disposal, in the author's opinion, those who raise the objection to electricity in mining on the ground of safety ought to bring some proofs of that danger, if it is to receive consideration. Notwithstanding the extended use of electricity, these accidents do not occur, and, in the opinion of many well qualified to give it, the danger arising from electricity is less than that arising from safety lamps, and enormously less than that arising from almost any explosive agent now in daily use.

Having dealt with this question, it remains to be asked : Is the present position of power distribution by electricity such that we may use it with confidence for the whole of a power required at a colliery? The author's answer to this is, yes. In support of this may be given the following facts. The largest engine at a colliery is the winding engine, and, supposing this to require to be capable of developing power at full speed of 1000 h. p., which is an outside figure, this could be well replaced by two motors of 500 h. p., one on each end of the shaft of the drum, without gearing. There are numerous cases of dynamos and motors of this power working with ease and satisfaction and giving no difficulty whatever, and operated by ordinary mechanics with no more trouble than an ordinary steam engine.

Motors of smaller sizes are in use all over the world, and with universal satisfaction as to ease of manipulation and low cost of maintenance. Are the claims made for efficiency of electric distribution of power realized? On this point the author has examined carefully tests made by himself and by others on electric-power plants, and has arrived at this conclusion: while the efficiency of distributing electric power and its utilization in the motors come up to that claimed, the efficiency of the production of electricity is not, as a rule, as high as is claimed, or as high as may be realized. The reason is this: sufficient account is not taken of the fact that the average load is considerably less than the maximum requirement, and the curve given, which is taken from an actual test of a direct-coupled engine and dynamo, will show how this operates. While the efficiency of electric generation—that is, the proportion between the electric power delivered to the cables and the indicated horse power of the engine—is as high as 86 per cent. at full load, it falls to 74 per cent. at half load and to about 58 per cent. at one-quarter load. The reason for this is to be found in the power the engine takes to drive itself. The engine is generally arranged to work with an economical cut-off at the full load or maximum power, and consequently is larger than necessary for all smaller loads. It should be arranged to work with an economical cut-off at the average power; then at a larger power, although the consumption of steam per indicated horse power would be somewhat larger, the mechanical efficiency would be so much better at the average load that considerable economy, and, indeed, the best possible result, would be obtained. The moral is to use engines with automatic expansion valves, permitting the engine, if a simple one, to work with a cut-off as late as one-half or five-eighths of the stroke when developing the maximum power, and working with a more economical grade of expansion at the average load.

To apply the principles advocated in this paper, the method to be adopted should be as follows: when a colliery is opened, an estimate must be made of the power which will ultimately be required for the whole colliery. It need not be all provided for at once, but the arrangements must be such that what is provided will be worked at an economical load, and that by simple duplication it may be increased. Suppose an example is taken which may be considered to represent an average case, where there is no very heavy pumping.

TABLE OF POWER REQUIRED AT A COLLIERY.

	Maximum power. Horse-power.	Average power. Horse-power.	Minimum power. Horse-power.
Winding	700	225	0
Fan engine	60	60	60
Pumps (say)	50	50	50
Haulage	200	100	0
Lighting	20	10	10
Screens	20	20	20
Shops at surface	20	5	5
Capstans for wagon handling	20	10	10
Total	1090	480	155

The power required by the winding and haulage engines are what would probably be required in a colliery drawing about 1500 tons per day, and the maximum power required by the winding engine is reckoned on the assumption that the weight of the ropes is unbalanced, and the average upon the assumption that the winding takes 40 seconds, and the unloading and loading 25 seconds. Variations will correspondingly affect these points, and must be made to suit each case. These powers are those required at the separate machines, and, if we take it that the loss in the cables at full load is 5 per cent., which will be ample, as the bulk of the power is not far from the source, and that at the average load and upwards the indicated power is as shown on the curve (steam dynamo efficiency),—that is, $\frac{100}{86}$ of the power delivered to the cables,—we get the following as the indicated power required at each load, which, assuming that the electric motor will transform only as much electric power into mechanical power as a steam engine would convert of indicated power into mechanical power, gives a direct comparison between the actual indicated power required if all the engines were worked direct from the boiler or by the distribution thus to be effected.

INDICATED HORSE-POWER OF GENERATING ENGINES.

Maximum.	Average.	Minimum.
$\frac{100}{86} \times \frac{100}{95} \times 1090;$	$\frac{100}{86} \times \frac{100}{97.5} \times 480;$	$\frac{100}{64} \times \frac{100}{95} \times 155$
$= 1330$	$= 572$	$= 255$

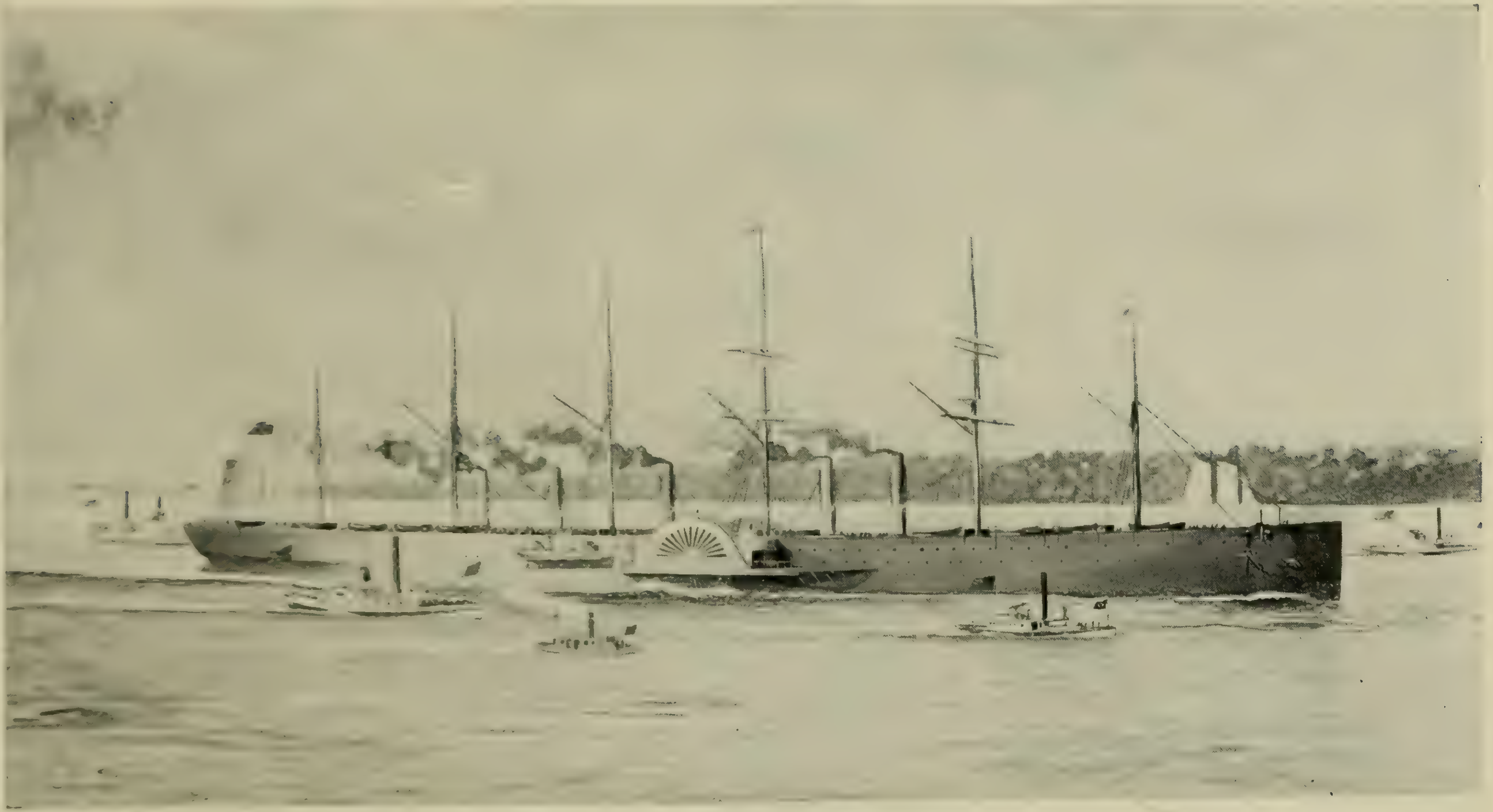
Now, it will be observed that the average power is 572 indicated horse power, as compared with 480 indicated horse-power actually required at the engines. But taking for the former Mr. Forster

Brown's figure of 6 lbs., and for the latter 1½ lbs., the economy resulting is found from the fraction:

$$\frac{6}{15. \times \frac{572}{480}} \text{ or } \frac{6}{1.78} \text{ or } \frac{100}{9.6}$$

not far differing from the possible economy spoken of early in the paper. That such figures are realizable in practice is shown by the figures given in a paper read before the North of England Institute of Mining Engineers by Mr. Alexander Siemens. Tests are there recorded where, with a plant considerably smaller than that here considered, a consumption of 2.62 lbs. per e.h.p. hour, equivalent to 2.25 lbs. per indicated horse-power hour, was obtained; and in the discussion on the same paper reference was made by Mr. D. B. Morison to a plant using 2 lbs. coal per e.h.p., equivalent to 1.72 lbs. per indicated horse-power. The use of triple-expansion instead of compound engines would further reduce this to the figures named above.

The writer is aware that in thus advocating the generation of the whole of the power in one engine or pair of engines he is advising a very radical departure from existing and well-tried methods; but the advantage in economy is so great that, in his view, a revision of method must take place, and in any case the subject is well worthy of consideration and discussion.



THE GREAT EASTERN. LARGEST STEAMSHIP EVER CONSTRUCTED, 1859.

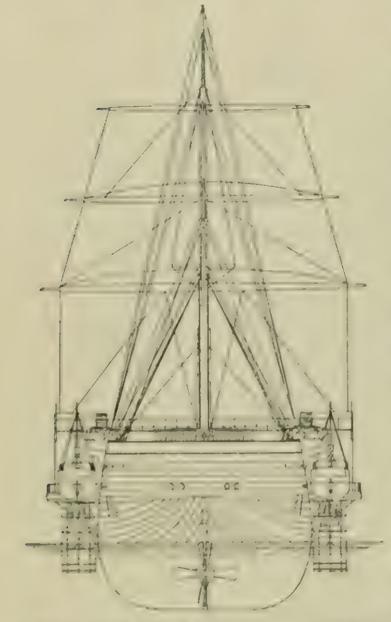
Had paddle-wheel and screw engines; 10 boilers; iron hull; length 680 feet; tonnage 32,160.

THE TRANSATLANTIC STEAMERS OF 1856 TO 1880.

By Samuel Ward Stanton.

WHEN, in 1852, the steamship Australian began running on the mail line between England and Australia, it was found that, on account of the expense attached to supplying coal depots at certain points on the route (the steamer being unable to carry enough fuel to make a straight voyage), the round trip caused a loss of from £1000 to £10,000, even when the vessel carried a full cargo and complement of passengers. On her first trip the Australian was 221 days in making the round voyage, 165 of which had been steaming days at sea, the other 56 being passed in port. The coal at the different points at which she stopped had been previously sent out in sailing vessels for her use exclusively. With his experience in mind a company was formed in England in 1853-4 to construct a vessel large enough to carry all the fuel she might need in a voyage from England to Australia and back, and to steam at the rate of 18 miles an hour. Accordingly the noted engineer Brunel designed a vessel of enormous proportions, and a company, known as the Eastern Steam Navigation Company, was organized, the capital of which was £1,200,000, in shares of £20 each, with power to increase the same to £2,000,000. The money was soon subscribed, and on May 1, 1854, the first plate of the Great Eastern was laid in the yard of J. Scott Russell & Co., at Millwall-on-the-Thames.

The hull of the Great Eastern was double-built,—that is, she was constructed with an inner and an outer skin, these being placed 2 ft. 10 in. apart, with longitudinal webs at intervals of 6 ft. running the whole length of the vessel, these being subdivided by transverse plates into water-tight spaces of about 6 ft. square, thus insuring safety should the outer part of the iron hull become fractured. Many steamers are now built on this principle, notably those of the Fall River Line, running on Long Island sound. The hull of the Great Eastern was divided by transverse bulkheads into twelve water-tight compartments below the lower deck, and nine above the lower deck, and it was contended that two of these compartments might be filled with water without danger to the ship. In addition to these transverse bulkheads, there were two which extended from the bottom of the ship to the upper deck, running longitudinally for a length of 350 ft. There was no keel, the bottom being flat, and in shape below the water line she was quite similar to fast Hudson River boats of the period, having very fine lines and a long, sharp bow. The iron plates of the hull were ¾ in. in thickness, while the plates forming the keel were 1 in. thick. The average size of the plates, of which there were thirty thousand, was 10 ft. by 2 ft. 9 in. About 8000 tons of iron were used in the construction of the hull.

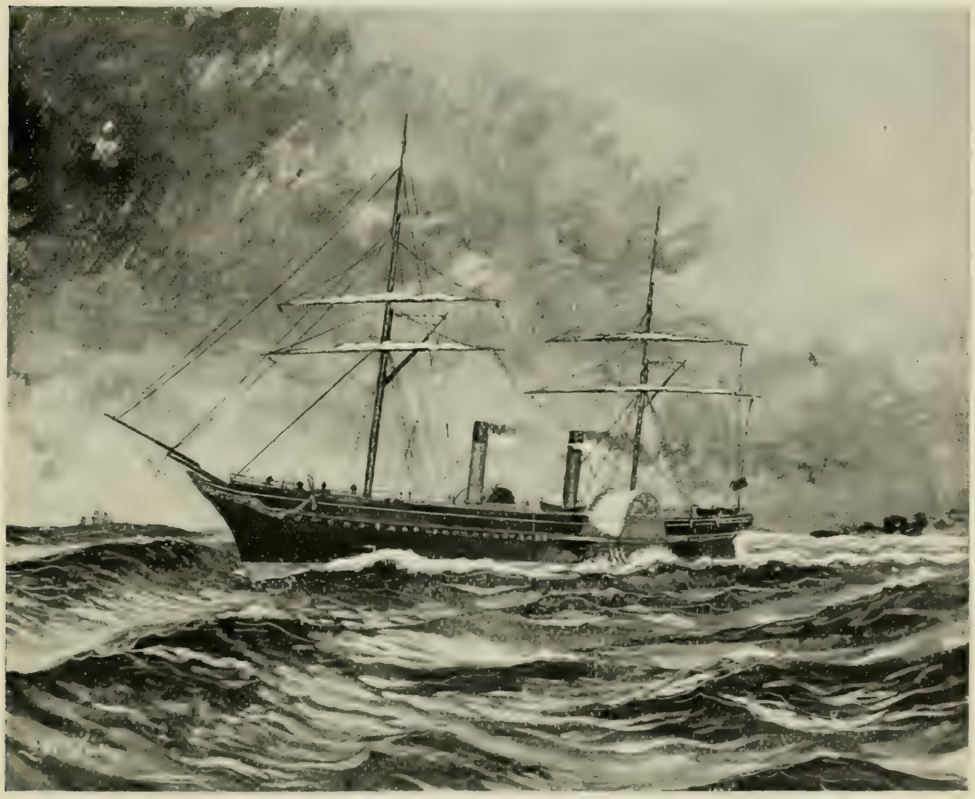


THE GREAT EASTERN. STERN ELEVATION.

There were six masts, two square-rigged and others carrying fore and aft sails only, the larger masts being iron tubes and the smaller of wood. The funnels were double, the space between the inner and outer skin being intended to hold water. She was the first English steamship built without the proverbial bowsprit and figure head,—a style that was copied from American steamers. Though the Great Eastern was intended for the Australian trade, she never made a trip to that place. Her first trip was made from Liverpool to New York, where she arrived on June 28, 1860, the greatest speed attained during the passage being 14½ knots an hour. The distance run was 3188 miles, and her greatest day's steaming was 333 miles. The total consumption of coal was 2877 tons.

At the time the Great Eastern came out, an ocean voyage was an undertaking which only the hardiest of sailors—those used to the sea—cared to indulge in; only those who were obliged to go on business embarked without much contemplation; all others weighed the matter carefully, giving much thought before making up their minds to trust themselves on board of one of the steamers of the time, which often came into port bearing the marks of the terrible shaking up they had received from old ocean. And the passage of from 10 to 15 days in the stuffy, ill-ventilated cabins was an experience which few cared to indulge in often. But with the advent of the Great Eastern these discomforts were over, in a measure, for she was a vessel of such stupendous size that the elements affected her comparatively little. The following is taken from an account written by a passenger on her first trip:

I still found it blowing very hard, and the sea covered with a thread-like foam, which filled the hollows as well as whitened on the billow tops. Still, the ship rolled only eight degrees, and her stately nod did not disturb a plate upon the table. The storm-rack was laid at breakfast to protect the dishes, but it was not needed, for my full tea-cup sat outside of it without being in the slightest peril of a slip. Nevertheless a 3000-ton ship would have been pitching sadly. The motion did not succeed in making a single person sea-sick, though there were among her passengers several who had never been to sea before. The wind moderated still more during the afternoon, and we set all our topsails. . . . Nothing could be more beautiful than to stand upon an elevated grating in her bow and see her stern lift itself majestically against the sky as we dropped into some yielding wave before us, or to behold her rising sideways to her equilibrium. . . . I could hardly realize, as I viewed her buoyant step upon the deep, that ten thousand plates of iron, representing 12,000 tons of inert metal, clamped by three million rivets, and bearing within, besides her ponderous engines, 6000 tons of coal, could career thus, cork-like, upon the bosom of the thin and shifting element below. . . . The most striking idea of her size, however, and the greatest demand upon your wonder that she swims so lightly, is obtained by going down by her sponsons, outside and aft the paddle-boxes, which enables you to see her entire towering section abaft the wheel. From that point you face up and down her massive sides and see the black warehouse—for it does not look like a ship—grandly rise and fall in the hissing and downy foam which the wheels send flying by her run. . . . It is only when in comparison with some other object that the Great Eastern sensibly exhibits her huge proportions to an accustomed eye, and then everything else is dwarfed by her neighborhood.



STEAMSHIP SCOTIA, CUNARD LINE, 1862.

Last British Transatlantic Paddle Steamship. Length 379 feet; tonnage 3871.

During the following 3 years she made a number of trips to New York, but, owing to a lack of freight at profitable rates, she was a

ANCHOR LINE STEAMSHIP, DEVONIA, 1877.

Length 400 feet; tonnage 4269.

constant source of loss to her owners. She was destined, however, to perform one of the greatest feats that had ever been consummated for the benefit of mankind, and this was the laying of the Atlantic cable in 1866. A previous attempt had been made, in 1865, but the cable broke in mid-ocean. The British government used her occasionally as a transport. In 1867 she was again fitted up, at great expense, to ply between England and New York. She made one trip, and on her return was seized at the instigation of the seamen, who claimed unpaid wages. When this matter was adjusted, she was leased for cable-laying purposes, and in 1869 laid the French Atlantic cable. She then went to the Persian Gulf and laid the cable from Bombay to Suez, in 1870, and in 1873 and 1874 laid the fourth and fifth Atlantic cables, and afterward laid other cables. She has only lately been broken up on the banks of the Mersey. For dimension details see page 260.

The last and the grandest of the paddle-wheel steamships built for the Cunard Line was the Scotia, which came out in 1862. She was almost identical in all respects to the Persia of 1855, although her lines were finer and she possessed greater power. These two steamers were unquestionably the handsomest paddle steamers that ever ran across the Atlantic, and from a marine point of view were as perfect and graceful as it would be possible to make a paddle steamer designed for ocean service. The New York *World* of May 11, 1876, contained the following:

> The oldest and the newest of the great ships of the Cunard Line – the Scotia and the Scythia – arrived together yesterday, bringing, between them, more than three hundred cabin passengers. The arrival of the Scotia may be regarded as, in its way, a "Centennial" event, that stout old paddle-wheeler having been withdrawn some time ago from the line, and put on again chiefly, we believe, to accommodate the special centennial passengers of the year.

Thus, in a dozen years, the Scotia had been relegated to a back place in the transatlantic fleet, although as stanch a vessel as the newest of them, and of great power and excellent speed. But the march of improvement had continued, and the unwieldy paddles were superseded by the more compact screw, the new type of engine furnishing as great power with much less consumption of fuel. The Scotia burned an enormous amount of coal when compared to the modern screw steamers, and so, when the British Telegraph Construction and Maintenance Company purchased her in 1879, after she had been laid up in England, her paddle engines were removed and twin screw machinery was placed in her, since which time she has done valuable service, her hull being almost as stanch and showing its beautiful lines as well as when first launched.

Following the Scotia, all new steamers built by the Cunard Line for the transatlantic trade were supplied with screws, and the same year that this famous vessel appeared the screw steamship China was built, which was eminently successful. The Cuba, Java, Russia, Abyssinia, Algeria, Bothnia, Scythia, and others, came after, the line continuing to be one of the leading companies operating upon the Atlantic.

Messrs. Handyside and Henderson, in the year 1856, refitted the sailing vessels Tempest and John Bell, placing in them propeller engines, and with another steamer, the Inez de Castro, inaugurated the well-known Anchor Line, the route of which was from Glasgow to New York; previous to this year they had been running sailing vessels between Glasgow and the Mediterranean, and this route was also continued. The line received no aid from the government, but with good management soon became of importance. By 1880 twenty-three steamships had been constructed for the Atlantic service, and more than thirty for Mediterranean trade.

The Hamburg-American Line, established in 1847 as a line of sailing packets, in 1853 ordered its first steamers, the Borussia and Hammonia, the former beginning the regular service between Hamburg and New York in 1856 and making the trip in 14 to 15 days. The

ANCHOR LINE STEAMSHIP, CALIFORNIA, 1872.

Length 361 feet, tonnage 3410.

North German Lloyd started its line from Bremen in 1858 with the steamers Bremen, New York, Hudson, and Weser. The Glasgow Line of steamers to New York, consisting of three boats, was discontinued in 1859, owing to poor business and the loss of the steamship New York. The French Line between New York and Havre was started in 1862. In 1863 the National Steam Navigation was established, in Liverpool, and three steamers, the Louisiana, Virginia,

ANCHOR LINE STEAMSHIP, ANCHORIA, 1874.

Length 408 feet; tonnage 4168.

and Pennsylvania, were placed on the route from that port to New York. The next year the line was reorganized and became known as the National Steamship Company, and has since been identified with steam navigation across the Atlantic. The Italy, built in 1870, was the first Atlantic steamship fitted with compound engines, and may be considered an important vessel.

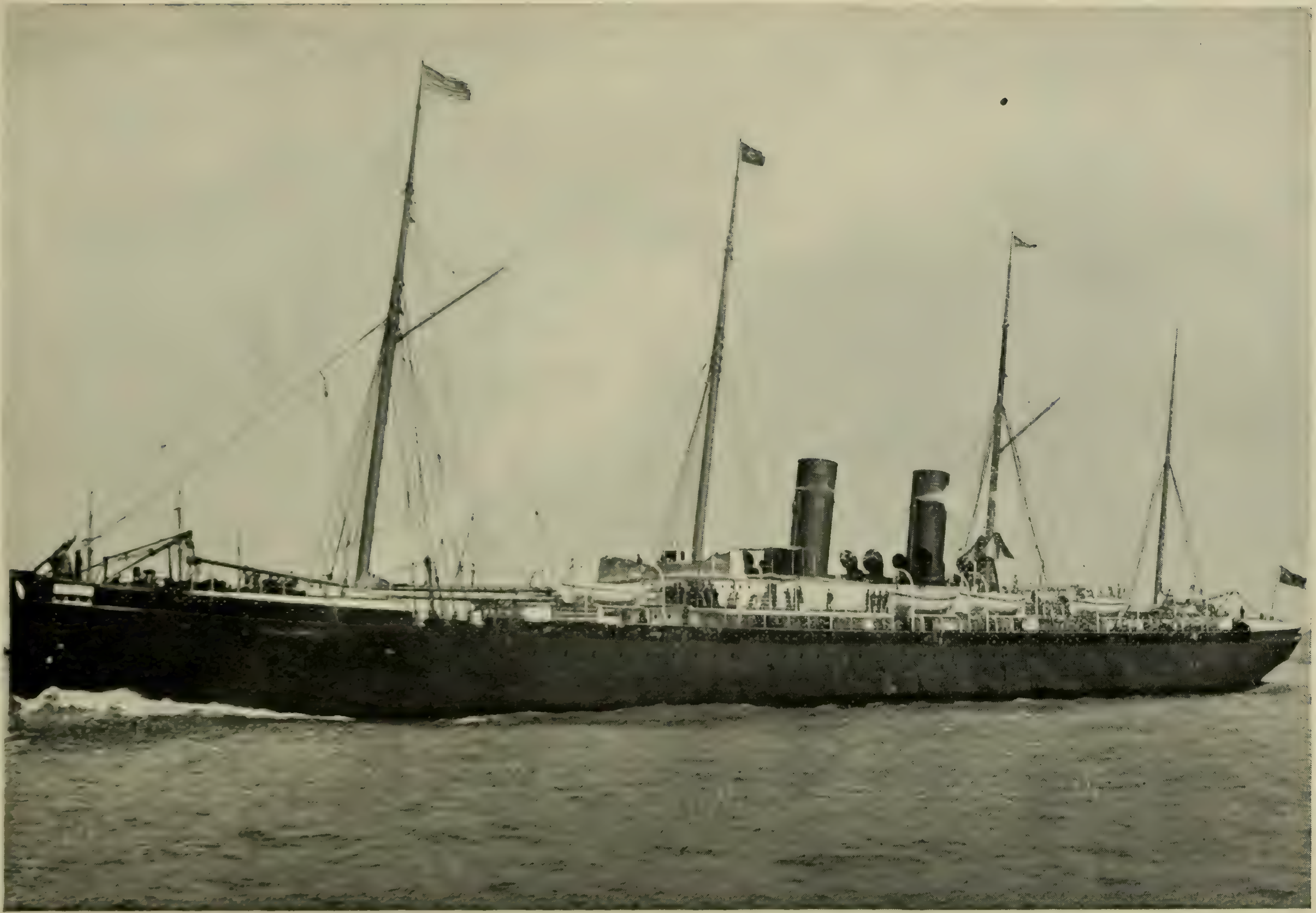
Following the National Line, the next transatlantic company organized was the well-known Guion Line, which commenced operations in 1866, the first steamer being the Manhattan, a fine ship. She was followed by the Chicago, Minnesota, Nevada, Idaho, Wyoming, Wisconsin, etc. The two latter vessels were among the first steamships to have compound engines.

STEAMSHIP MANHATTAN. FIRST STEAMER OF THE GUION LINE, 1866.

Length 335 feet; tonnage 2869.

In 1866 Messrs. Ruger Brothers, of New York, with associates, started the North American Lloyds, which company purchased the steamers Atlantic, Baltic, and Western Metropolis, and chartered the Ericsson, Merrimack, Mississippi, and Northern Light, running them between New York and Bremen, touching at Southampton both ways. The line was unsuccessful, and in 1867, in connection with other parties, the New York & Bremen Steamship Company was formed. The Atlantic, Baltic, and Western Metropolis were taken over, the Northern Light was chartered, and these four steamers plied between New York and Bremen, but with no better results. In 1868 Messrs. Ruger chartered the Arago, Ariel, Circassian, Northern Light, and Quaker City, and ran them between New York and Bremen, but the field was finally abandoned to the North-German Lloyds. In 1869 the Messrs. Ruger chartered the steamers Ariel, Fulton, Guiding Star, Northern Light, and Santiago de Cuba, placing them on the route to and from New York, Stettin, Copenhagen, and Christiansand; they also chartered the Ocean Queen and Rising Star in 1870; but the line did not pay and was abandoned.

The famous White Star Line, one of the best known of the Atlan-



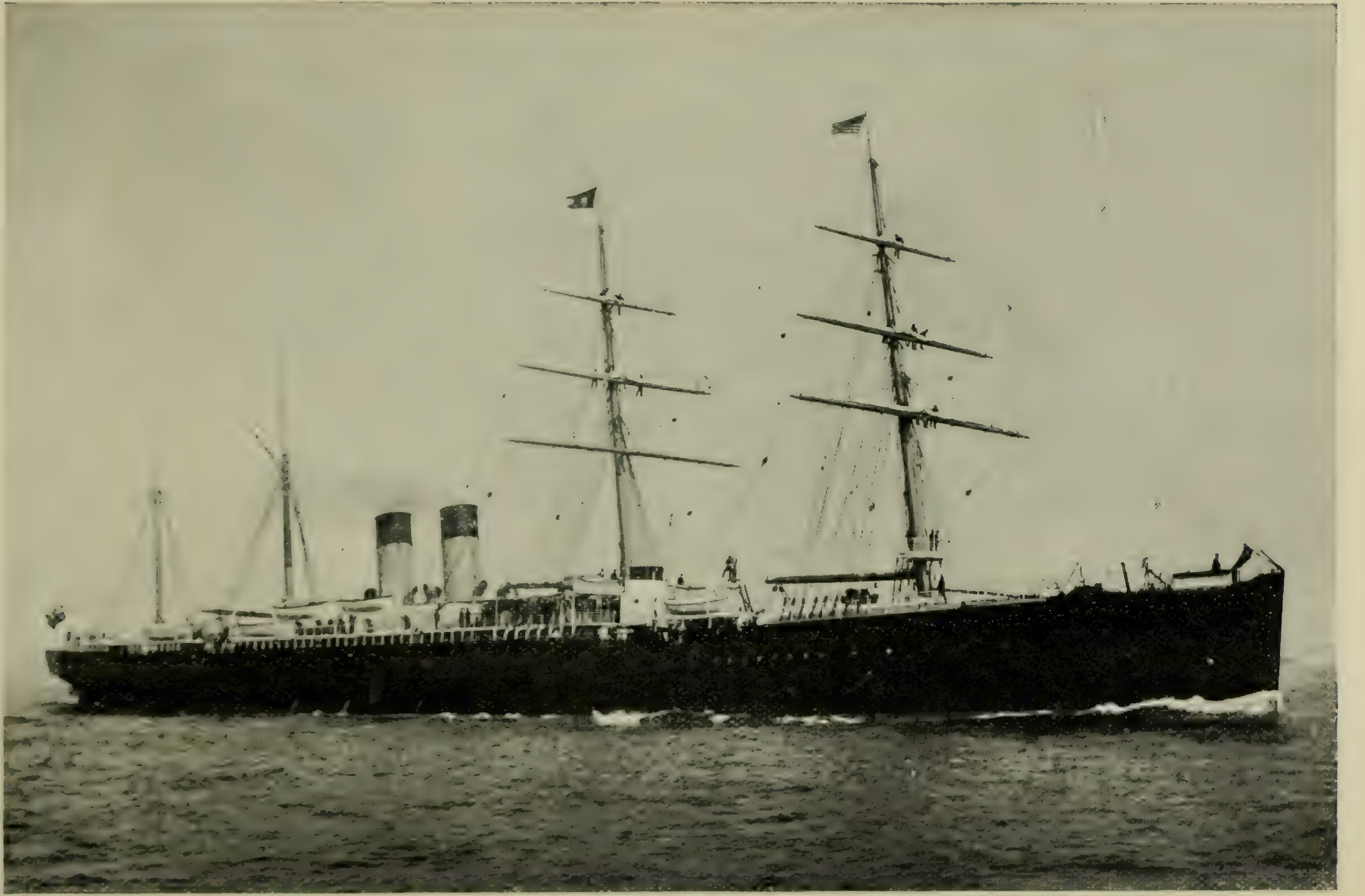
GUION LINE STEAMSHIP, ARIZONA, 1879. LENGTH 464 FEET; TONNAGE 5164; FASTEST ON THE ATLANTIC WHEN SHE APPEARED.

tic lines of the present day, was at one time composed of sailing packets which plied between England and Australia, over 40 years ago, in the course of 7 years conveying about half a million adventurers to the gold fields. In 1867 an important change took place; the managing owner retired, and the flag was taken over by Mr. Thomas Henry Ismay, who began by introducing iron ships instead of the wooden clippers then in use. In 1869 Mr. Ismay established the Oceanic Steam Navigation Company, Limited, and the advent of its first steamer, the Oceanic, in 1870, may be said to have marked an epoch in the annals of passenger travel on the ocean. Instead of having the saloon and state-rooms in the after part of the vessel, this boat was designed with the first-class passenger accommodation amidships, this being nearest the center of gravity, thus reducing many of the discomforts which had hitherto marked a voyage across the ocean. The Oceanic, therefore, was the pioneer of the present high-class ocean steamers in the matter of interior arrangements. She is still in existence, having been in use on the Pacific since 1875, other steamers taking her place on the Atlantic route. The following is taken from the Liverpool *Mercury* of May 4, 1895:

THE PIONEER OF THE WHITE STAR LINE, STEAMSHIP OCEANIC, 1871.

First Atlantic Steamer with Cabins Amidships. Length 420 feet; tonnage 3208.

> A NOTABLE STEAMSHIP.—The White Star steamer Oceanic arrived at Plymouth on Wednesday morning from Hong Kong and Singapore. The Oceanic was the pioneer steamer of the White Star fleet. She was launched on the 27th August, 1870, and has, therefore, been afloat a quarter of a century. It is given to few ocean steam-



WHITE STAR LINE STEAMSHIP, BRITANNIC, 1874. ONE OF THE FINEST STEAMERS EVER BUILT. LENGTH 455 FEET; TONNAGE 5004.

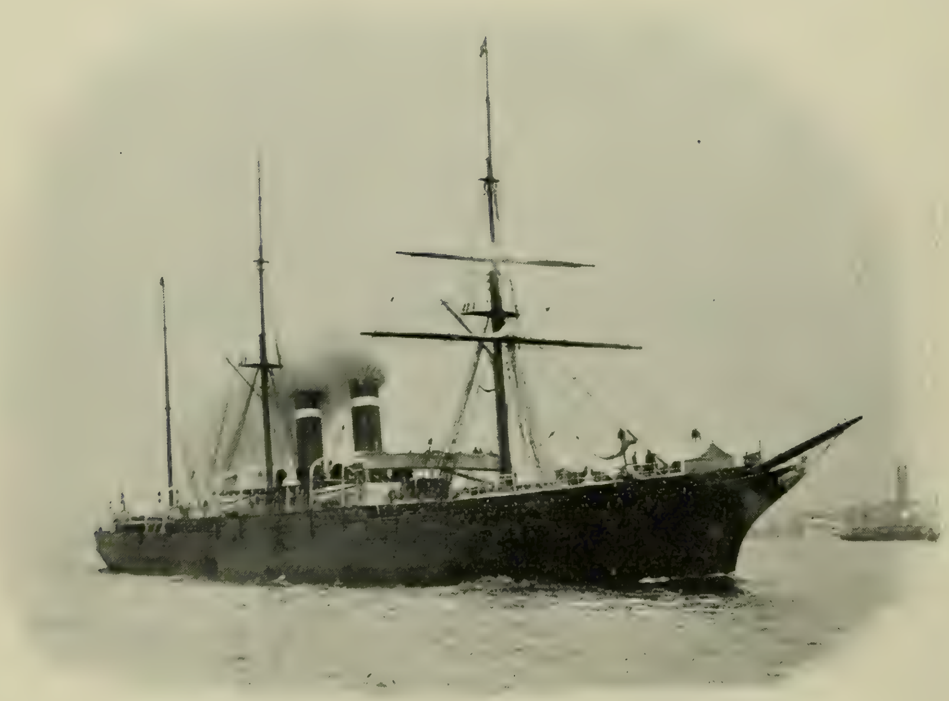
RED STAR STEAMSHIP, BELGENLAND. 1878.

Length 402 feet; tonnage 3692.

ers to do such marvellous work as the Oceanic has done. Coming as an entirely new departure, the veritable type of the modern passenger liner, with saloon and staterooms amidships and other innovations, she ran thirty-three voyages with great success, and achieved a high reputation for speed and comfort in the Liverpool and New York trade. She was then sent out in April, 1875, just 20 years ago, to the Pacific, to run between San Francisco and Hong Kong under charter to the Occidental and Oriental S. S. Co. of San Francisco. At the end of 1879 she came home to be reboilered, re-

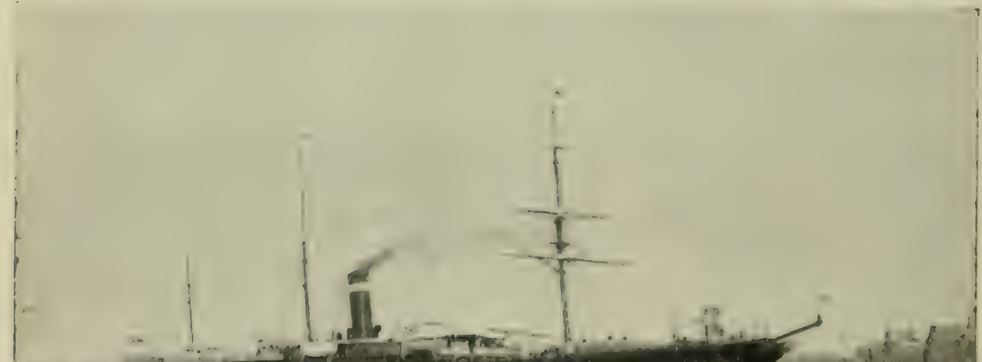
RED STAR [AMERICAN] LINE, STEAMSHIP WAESLAND. ORIGINALLY CUNARD STEAMSHIP, RUSSIA, 1867.

Length 358 feet; tonnage 2959.



INMAN LINE STEAMSHIP, CITY OF CHESTER, 1873.

Length 475 feet; tonnage 4770.



INMAN LINE STEAMSHIP, CITY OF BERLIN, 1875.

The largest and one of the fastest steamships of the time; tonnage 5526.

turning to her station in March, 1880, since when she has not once been taken off, but has continued uninterruptedly performing her work with regularity and efficiency.

Following the Oceanic came the Baltic, Republic, Adriatic, and Celtic, built and put into commission the following year. Besides these there were the Asiatic, Tropic, Gaelic, and Belgic, which were afterwards sold. Two of the most important vessels that have been built for the Atlantic trade were the Britannic and Germanic White Star liners, which appeared in 1874 and 1875, these steamships being the first to reduce the passage to less than 7½ days. While dozens of faster and larger steamers than these have since been built, these two splendid craft are as comfortable, and make their voyages with as much regularity, and almost as swiftly, as the more modern vessels.

The American Steamship Company was organized in Philadelphia in 1871 with a capital of $2,500,000, and soon afterward contracted with William Cramp & Sons for the construction of four steamships of the first class, of 3000 tons burden, to ply between Philadelphia and Liverpool, *via* Queenstown. These boats were named Pennsylvania, Ohio, Indiana, and Illinois, and have been running constantly since they were launched. They have a capacity of 100 first-class, 75 intermediate, and 800 steerage passengers, and 3500 to 4500 tons of freight. The State Steamship Line was established in 1872, running its ships between Glasgow and New York. The Red Star Line of steamers, between Antwerp and New York and Philadelphia, was inaugurated in 1873, and has been an important North Atlantic line since its inception. The Monarch Line was established in 1874, but went out of existence after about 10 years of service. The Warren Line of steamers, from Liverpool to Boston, and the Wilson Line, from Hull to New York, came into existence in 1875. The Leyland Line of steamships started in 1876, on the Liverpool and Boston route, and Johnson & Co. began running steamers between Liverpool and Baltimore in 1880.

The Cunard Line screw steamship Bothnia came out in 1874, and, as an example of the wonderful progress achieved since the first steamer of the line, the Britannia, built in 1840, crossed the ocean, the following facts are given. The Britannia measured 1139 tons and had a capacity for but 225 tons of cargo, while the Bothnia, of 4556 tons, could carry 3000 tons, or nearly fourteen times as much, though only four times larger. The Britannia carried 90 passengers, whereas the Bothnia had accommodations for 349. The former steamed 8½ knots, while the latter steams 13 knots an hour, or more than half as quick again, with less than half the coal per indicated horse power per hour, and at about the same fuel consumption per mile run.

It required 6 tons of coal to carry a ton of freight across the Atlantic on the paddle steamship Persia, built in 1855, whereas but $\frac{1}{5}$ ton of coal per ton of freight was used on the Arizona in 1880, although the latter vessel was twice the size of the old Cunarder.

As a comprehensive summary of the principal points of interest in this article the table below is presented. It will be interesting to note the tendency in the later designs as shown by the dimensions given in the fourth column.

PROMINENT TRANSATLANTIC STEAMSHIPS, 1856–1880.

Year Built.	NAME.	Tonnage	Le'th; br'th; depth, in feet	REMARKS.
1854-9	Great Eastern	22500	680×83×58	Largest vessel ever constructed Built on Thames.
1856	Borussia	2349	317×40×28	First Hamburg-American steamer; built by Caird & Co., Greenock.
1858	Bremen	2674	318×40×26	First North German Lloyd steamer; built by Caird & Co., Greenock.
1860	Marathon	2403	336×36×25	Cunard Line; built by Thompson, Govan; lengthened 1873.
1862	Scotia	3871	379×47×30	Cunard Line; last paddle steamer; built by Napier & Sons.
1862	China	2529	326×40×27	Cunard Line; built by Napier & Sons, Glasgow
1866	City of Paris	2875	385×40×26	Inman Line; built by Tod & McGregor, afterwards Tonquin.
1866	Manhattan	2869	335×42×28	First Guion Liner; built by Palmer, Jarrow-on-Tyne.
1867	Russia	2959	358×42×28	Cunard Line; afterwards Waesland.
1867	France	3572	385×42×28	National Line; built in Liverpool.
1869	City of Brussels	3747	390×40×27	Inman Line; built by Tod & McGregor, Glasgow.
1870	Italy	4169	389×42×28	National Line; first with compound engine; built by Elder.
1870	Wisconsin	3700	378×43×32	Guion Line; built by Palmer; mate to Wyoming.
1871	Spain	4512	425×43×36	National Line; built by Laird Bros.
1871	Oceanic	3208	420×41×32	First steamer White Star Line; built by Harland & Wolff.
1871	Adriatic	3888	437×40×31	White Star Line; built by Harland & Wolff, Belfast.
1872	Montana		400×43×40	Guion Line; had mate in Dakota.
1872	Pennsylvania	3128	343×43×24	American Line; Ohio, Indiana, and Illinois; sister ships.
1872	California	3410	361×40×31	Anchor Line; built at Govan, Scotland.
1873	Ethiopia	4005	402×40×33	Anchor Line; built at Govan, Scotland.
1873	City of Richmond	4780	440×43×34	Inman Line; built by Tod & McGregor, Glasgow.
1873	City of Chester	4770	475×44×36	Inman Line; built at Greenock.
1874	Bothnia	4535	422×42×34	Cunard Line; built by Thomson, Glasgow.
1874	Anchoria	4168	408×40×33	Anchor Line; built at Barrow, Eng.
1874	Scythia	4556	425×42×33	Cunard Line.
1874	Gellert	3584	375×40×32	Hamburg-American Line; built at Glasgow.
1874	Britannic	5004	455×45×33	White Star Line; built by Harland & Wolff.
1875	City of Berlin	5526	488×44×34	Inman Line; built by Caird, Greenock.
1875	Germanic	5008	455×45×33	White Star Line; built by Harland & Wolff.
1877	Devonia	4269	400×42×32	Anchor Line; built in Barrow.
1878	Gallia	4809	430×44×34	Cunard Line; built by J. & G. Thomson.
1878	Belgenland	3692	402×40×30	Red Star Line; built by Barrow S. B. Co.
1879	Buenos Ayrean	4005	385×42×30	Allan Line; first steel transatlantic steamer.
1879	Arizona	5164	464×46×37	Guion Line; built by Elder & Co., Glasgow.
1880	State of Nebraska	4000	385×43×34	State Line; built by Lpl. Forge Co., Glasgow.
1880	Furnessia	5494	445×44×34	Anchor Line; built by Barrow S. B. Co.

The steamers of the Inman Line have always held their own in the race for leadership on the North Atlantic. Their steamers City of Paris, 1864, City of Brussels, 1869, City of Chester, 1873, City of Richmond, 1873, and City of Berlin, 1874, were among the largest and finest when they appeared. The latter was the largest of the fleet running across the Atlantic, and made a splendid record as soon as she appeared, eclipsing the time made by the White Star Line steamers.

One of the most noteworthy steamers of the time was the Guion Line steamer Arizona, which came out in 1879. She was of large size and superior finish, having many improvements and machinery of a new design, the compound engine having three crank shafts with three cylinders. She made the fastest transatlantic passages in 1879 and 1880.

At the close of the year 1880 the first steel steamship for the Liverpool & New York trade, the Cunard liner Servia, was being built. While this vessel was the first one constructed of steel to ply to New York, yet the honor of the first transatlantic steel steamship belongs to the Allan Line,—the Buenos Ayrean, 1879, and Parisian, 1880, being the pioneer steel boats. Soon after 1880 the first twin screw and the first triple expansion engined steamers appeared.

FASTEST PASSAGES OF TRANSATLANTIC STEAMERS BETWEEN NEW YORK AND QUEENSTOWN, 1856–1880.

E, eastward; W, westward.

1856	Persia, Cunard Line,	E, 2732 knots	9 days	1 hour	45 min.
1857	“ “ “	W, 3070 “	9 “	21 “	41 “
1863	Scotia, “ “	E, 2731 “	8 “	3 “	0 “
1864	“ “ “	W, 2783 “	8 “	15 “	45 “
1866	“ “ “	W, 2851 “	8 “	4 “	34 “
1867	City of Paris, Inman Line,	W, 2700 “	8 “	4 “	1 “
1869	City of Brussels, “ “	E, 2786 “	7 “	22 “	3 “
1872	Adriatic, White Star “	W, 2778 “	7 “	23 “	17 “
1873	Baltic, “ “ “	E, 2843 “	7 “	20 “	9 “
1875	City of Berlin, Inman, “	W, 2829 “	7 “	18 “	2 “
1875	“ “ “ “	E, 2820 “	7 “	15 “	28 “
1876	Germanic, White Star “	E, 2894 “	7 “	15 “	17 “
1876	Britannic, “ “ “	W, 2795 “	7 “	13 “	11 “
1876	“ “ “ “	E, 2882 “	7 “	12 “	41 “
1877	Germanic, “ “ “	W, 2830 “	7 “	11 “	37 “
1877	Britannic, “ “ “	W, 2802 “	7 “	10 “	53 “
1879	Arizona, Guion Line,	E, 2810 “	7 “	8 “	11 “
1880	“ “ “	W, 2761 “	7 “	10 “	47 “

GENERAL PARTICULARS OF THE GREAT EASTERN.

Length of upper deck	692 ft.
Length between perpendiculars	680 “
Breadth across paddle-boxes	118 “
Breadth of hull	83 66
Depth, from deck to keel	58 “
Number of decks	4
Displacement	32,160 tons
Number of masts	6
Diameter of masts	2 ft. 9. in. to 3 ft. 9 in.
Canvas, full sail	6500 sq. yds.
Number of anchors	10
Number of boats	20
Tonnage (old measure)	22,500 tons
Storage for cargo	6000 “
Capacity of coal bunkers	12,000 “
Draft of water, light	15 ft. 6 in.
Draft of water, loaded	30 ft.
Water-tight compartments	12

Paddle Wheels.

Diameter of paddle wheels	56 ft.
Weight of paddle wheels	185 tons
Length of buckets	13 ft.
Width of buckets	3 “
Number buckets each wheel	30
Length of shaft	38 ft.
Weight of shaft	30 tons
Length intermed. crank shaft	21½ ft.
Weight intermed. crank shaft	31 tons

Paddle Engines.

Nominal horse power	1000
Number of cylinders	4
Diameter of cylinders	6 ft. 2 in.
Weight of cylinders, including piston and rod	38 tons
Length of stroke	14 ft.
Strokes per minute	14

Paddle Engine Boilers.

Number of boilers	4
Furnaces to each	10
Length of boilers	17 ft. 6 in.
Width of boilers	17 “ 9 “
Height of boilers	13 “ 9 “
Weight of each	50 tons
Weight of water	40 “
Area of heating surface	4800 sq. ft.
Number of tubes	400
Thickness of plates	3-8 and 7-16 in.

Screw Propeller.

Diameter of screw	24 ft.
Pitch of screw	37 “
Number of blades	4
Weight of screw	36 tons
Length of propeller shaft	160 ft.

Screw Engines.

Nominal horse power	1600
Number of cylinders	4
Diameter of each cylinder	84 in.
Length of stroke	4 ft.
Number revolutions per minute	50

Screw Boilers.

Number of boilers	6
Funnels to each boiler	12
Length of boiler	18½ ft.
Width of boiler	17½ “
Height of boiler	14 “
Weight of boiler	57 tons
Weight of water	45 “
Area heating surface	5000 sq. ft.
Number of tubes	420
Thickness of plater	7-16 and 1-2 in.
Number of auxiliary engines	4
Number of donkey engines	10
Total horse power, about	12,000

Passenger Accommodation.

Number of passengers (1st class)	800
Number of passengers (2d class)	2000
Number of passengers (3d class)	1200
Aggregate length of saloons and berths	350 ft.
Number of saloons	10
Length of principal saloon	100 ft.
Width	36 “
Height	13 “

WILL A BRIDGE ACROSS THE HUDSON RIVER PAY?

By Gustav Lindenthal.

INFORMATION on this point has been repeatedly asked, and an answer at this time appears appropriate. That a bridge over the Hudson river at New York is a pressing necessity is widely, and to many people painfully, known. The bridge for eight tracks (including approaches 3 miles long) authorized by congress from Hoboken in New Jersey to Twenty-third street in New York (admittedly the best location, and the only one worthy of serious consideration) will cost $21,000,000; $15,000,000 additional are required for right of way, approaches, and interest during construction. It will have a single span of 3100 ft. over the entire river. No saving in cost can be effected by a pier in the river, because a rock foundation can be had only at a depth exceeding 250 ft., involving hazardous and costly work. This was shown by the author years ago, and other engineers have since confirmed his judgment.

The steam and electrical railroads in New Jersey can be connected with those of New York city at a cost of $36,000,000, and, if this sum is paid out as fast as the work can be built, then 4 years will suffice for construction.

The bridge can be built only by private capital. It cannot, under the constitutions of the two States, be built at public expense, as was the existing Brooklyn Bridge, or as will be the new East River Bridge, which are both within the State of New York. Nobody assumes that congress would vote a credit for the bridge as an interstate route. Such a step would be regarded as a dangerous precedent.

Since money cannot be had for the bridge, either from the cities or States immediately interested, or from the national government, private capital alone must be looked to. That the railroad companies in New Jersey cannot very well aid in furnishing the capital was shown by the author in an article published in this magazine in November, 1893. The cost of the bridge is too great to be assumed by any one railroad, and a combination of several or all railroads for the purpose is impracticable: first, because of their rivalry in business; second, because of the great difference in their financial conditions. All, however, are willing to use the bridge on equal terms, if a separate company will build it in a location, equally accessible to all. The local traffic, on electric cars, will be an indispensable source of revenue, and this is not controlled by the railroads.

The financing of the bridge must, therefore, be based, as was that of the elevated railroads, on the merits of the undertaking. The promoters must be able to show a traffic which, at low rates, will pay good interest on the investment and a profit commensurate with the risk of construction.

The location of the bridge with relation to the local traffic is of the first importance. The more local traffic it can command, and the nearer the bridge can be located to the ferry lines having now the heaviest passenger traffic, the greater the business it will get.

A more favorable location than that from Hoboken in New Jersey to Twenty-third street in New York could not well be chosen along the entire river front. It will be equally convenient to all the thirteen railroads and several electric traction companies in New Jersey and to the down-town business and up-town residential districts in New York. It will be in the very heart of the hotel and theatre region and of the retail business and shopping centre, which will furnish the largest amount of travel during the day, between the morning and evening rushes.

The situation is analogous to that which prevailed in New York before the elevated railroads were built (1875–6). Every one then wanted rapid transit to the upper part of the city, just as every one is now shouting for a bridge over the North river. When the proposition to solve rapid transit by building elevated railroads to Harlem was laid before New York financiers, there was apparently not one argument in its favor which would stand scrutiny. "Do you think," it was asked, "that people are going to walk several blocks and climb stairs to stations, and pay 10 cents [the only fare thought of then], when they can ride on the street cars for 5 cents, and get on and off where they please? Do you mean to tell us that an iron viaduct road, costing at least fifteen times as much for construction per mile as a horse-car line, will pay under such circumstances?"

All these arguments, moreover, were strongly endorsed by the horse car companies, which were, of course, hostile to the idea of dividing their traffic with the elevated railroads.

The risk was considered great, and the money had to be raised at extraordinary cost, and, had the promoters believed that the fares would in a few years come down to a uniform 5-cent rate, or had they believed that the elevated railroads would be compelled to pay damages to property owners along their lines, it is doubtful whether one dollar would have been subscribed toward their construction. But every one knows now that the undertaking was eminently successful.

The elevated railroads furnish a better basis for estimation of the probable revenue from local traffic over the North River Bridge than does the Brooklyn Bridge, because the latter was built at public expense, almost regardless of time and cost, and because its managers, when it was finally completed, had to defer to public sentiment, which was against such management of the bridge as would yield interest charges and running expenses. The Brooklyn Bridge—with terminals, only 1 mile long—is managed as a separate concern, without much regard to the connections at each end. It has its own terminals, cars, motors, and crews,—a fact which makes its operation very expensive. The enormous number of passengers are obliged to change cars at each end, climb stairs, and walk long distances before they can continue their journey.* It is safe to say that, if the Brooklyn Bridge were owned by a private corporation, its owners would be compelled by self-interest to so arrange the bridge that the elevated and electric roads of Brooklyn could run their cars directly over to New York. In the case of the North River Bridge this privilege will be enjoyed by all kinds of railroads in New Jersey.

The North River Bridge and the elevated railroads in New York have, therefore, the following features in common: dependence upon private capital for construction; opening up new territory for homes and residential purposes; saving of time and greater convenience in travel; and an undoubted prospect of a vast increase of traffic. The only difference is this,—that the necessity for the bridge is felt to be much greater than the necessity for the elevated railroads or for the Brooklyn Bridge was felt to be at the time of their construction.

The elevated railroads began with 10-cent fares, competing with the 5-cent fares of the street railroads. Applying that experience to the proposed North River Bridge, we may expect that at the start an average 5-cent fare in local traffic will very well compete with a 3-cent ferry fare or even a smaller one. The ferry carries the passenger merely from shore to shore, leaving him to walk from and to the cars, where he pays additional fares. For instance, a passenger from Jersey City Heights to the retail district near Madison square in New York has to pay at present 13 cents (for one ferry and two street-car fares), and do considerable walking besides. If he is lucky in not missing connections at the ferry, he may complete his trip in 40 minutes; otherwise, in 50 minutes. Over the bridge the same trip will take 8 minutes and cost

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* In spite of these drawbacks, the traffic over the Brooklyn Bridge has increased from 8,823,000 in 1884 to over 43,000,000 in 1894, not counting the pedestrians (who pay no toll). Indirectly, it pays the two cities handsomely on the investment, and shows its great necessity side by side with the ferries, whose business, instead of having decreased, has, against all expectation, increased. The total number (bridge and ferry) of passengers across the East river now exceeds 135.000,000 per annum, against 41,000,000 ferry passengers in 1882,—1 year before the bridge was opened for traffic.

5 cents. Will not that saving of time and money increase travel immensely? Let experience elsewhere answer the question. With those who know the situation the conviction is strong that the bridge will cause the different cities and towns in adjacent New Jersey to grow into one dense metropolitan district, in population surpassing New York, where there is no more room for growth except to the far and inaccessible north.

Passengers from Bayonne and Greenville far away to the south will probably continue to use the ferries to lower New York in fine weather, but to the central part of New York they will use the bridge at all seasons as the shortest, cheapest, and most convenient route.

Passengers living in the pleasant suburbs of the Orange hills arrive now in one of the railroad stations in Jersey City or Hoboken, and walk to the ferry, on an average, 800 ft. After landing at one of the down-town ferry slips, the passenger finds no convenient cars to carry him to his office; he is obliged to walk (unless he chooses to hire the expensive cab) through the most disagreeable neighborhood of New York, with streets and sidewalks crowded and obstructed by every conceivable nuisance. He will gladly take, for a few cents more, the bridge route, from which the elevated railroad will carry him just where he wants to go, up or down town, with a saving in time of from 10 to 40 minutes. It will enable him and his family to come in the evening to New York to visit the concert or theatre, and return home, with no more trouble than if he lived near Central Park. People of a saving disposition may continue to use the ferries and climb over truck ladders. All American experience in passenger transportation, however, is against it. Increased convenience and saving of time always attracts traffic, in spite of somewhat higher fares; otherwise the elevated railroads in New York would have starved to death the first year.

As traffic increases, facilities can be extended, and passengers may have the further comfort of riding through from the Oranges to the Battery without change, on steam or electric cars, as the case may be.

As regards railroad passengers from a distance and with baggage, a higher rate of compensation over the bridge will be justified, and an average of 10 cents will be admitted as a moderate estimate. (Whether the toll be arranged in this or some other form is immaterial at present in discussing or estimating revenue.)

The number of ferry passengers crossing the North river in 1886 was 58,894,000; in 1890, 72,260,000; in 1894, nearly 85,000,000; and, at the present rate of growth, it will reach, in 1900, at least 100,000,000; 50,000,000 from Hoboken, Jersey City, and Newark; 38,000,000 from other towns; and 12,000,000 from a distance of 30 miles and over. On the New Jersey side, within a radius of 30 miles, there is a population of 1,250,000 tributary to the North River Bridge,—nearly equal to that on Long Island within the same radius, which at present supplies 135,000,000 passengers across the East river.

In the estimates of revenue, it is assumed that 40 per cent. of all passengers across the North river will use the bridge the first year,—namely, 32,000,000 local and suburban passengers at an average of 5 cents, and about 8,000,000 longer distance passengers with baggage, at an average of 10 cents; on the whole, 40,000,000 passengers at an average of 6 cents.

When it is considered that a large increase of population (larger than the ordinary rate of increase) will take place in the near-by towns and cities of New Jersey, in anticipation of the completion of the bridge, as soon as the work can be energetically prosecuted; that land for homes is cheap and unlimited in New Jersey within the sight of New York; that house rentals are only about one-half; and that a large region will be more quickly accessible than Harlem,—it cannot be said that either the number of passengers or the toll is placed too high. Still less will it be doubted that the number of passengers will rapidly increase from year to year. It is almost certain that the experience with the New York elevated railroads will be here repeated, if not outdone.

The growth of the elevated railroads was as follows: in 1879, 46,045,000 passengers; 1880, 60,832,000; 1881, 75,586,000; 1882, 86,361,000; 1883, 92,125,000; 1884, 96,703,000; 1885, 103,355,000; 1886, 115,107,000; 1887, 158,963,000; 1888, 171,529,000; 1889, 179,497,000; 1890, 185,833,000; 1891, 196,714,000; 1892, 213,692,000; 1893, 221,407,000.*

This increase took place without any increase in the length (32 miles) of the four parallel roads constituting the elevated railroad system in New York, and in competition with parallel street-car lines, whose business is equally large and growing. With such an experience before us, the conclusion can hardly be escaped that the bridge traffic, under the much more favorable conditions above-named, will certainly grow at a similar rate, and in 10 years reach, if not overlap, 160,000,000 passengers.

The North River Bridge is intended to be a thoroughfare for the railroads, and not an independently-conducted transportation route, like the Brooklyn Bridge. The Brooklyn Bridge carries one-third and the ferries two-thirds of the total number (135,000,000) crossing the East river, because the latter is comparatively narrow, the ferry lines numerous and conveniently located, and the time of the trip short. The passengers across the Brooklyn Bridge are not spared the discomfort of changing cars, and the consequent loss of time.

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* The entire street railroad traffic of New York city in 1887 was 164,000,000 passengers, or 148 trips per capita of population (1,107,000). Last year (1894) the streets and elevated railroads carried a total of 460,000,000 passengers, or at the rate of 250 trips per capita of population (1,840,000), proving that increased convenience of travel increases the capita rate of travel.

The North river, on the other hand, is twice as wide as the East river, and the ferry lines are less conveniently located, particularly to the business center of New York. The saving of time will be comparatively very much greater, with the almost certain result that within a few years the bridge passengers over the North river will greatly outnumber the ferry passengers.

In the case of the North River Bridge there will be an important saving in the cost of terminals. The suburban traffic in New Jersey is being gradually absorbed by the electric railroads, which will not require the extensive terminal arrangements in New York that are needed for locomotive trains. A loop connection between the incoming and outgoing tracks will be sufficient. A very large passenger traffic can be handled with that arrangement. The through trains of all kinds require more room, but for these the railroads, it is believed, will prefer to provide their own passenger stations.

Another item of revenue will be that of perishable freight (including milk, fruit, meat, and other food products), of which there are about one thousand one hundred cars daily. The saving of time for this freight is so important that all of it can be expected for the bridge at the low tolls contemplated. In addition there is the express; then the through freight to and from New England (which will be limited only by the capacity of the New York Central Railroad to take care of it), and a certain proportion of the high-class local freight, which will depend upon the facilities for loading and unloading. The arrangement of freight stations separately built and owned by the railroads in St. Louis in connection with the Merchant Bridge gives an indication of the methods likely to be evolved for New York.

The rental from telegraph and telephone wires is also a considerable item, amounting, for instance, over the Brooklyn Bridge to over $22,000 per annum, and sure to be twice as much over the North River Bridge.

There is no doubt that the revenue will greatly increase from year to year, and in 10 years probably will reach the same amount as on the elevated railroads ($11,000,000), which have no revenue worth mentioning except the passenger traffic at 5 cent fares, and yet pay good interest on a capitalization of $70,000,000. It is true that more money will be invested, after the completion of the bridge, for the enlargement of terminals. But these will earn their own rentals.

The revenue for the first year, conservatively estimated, is as follows:

1.	Toll from 40,000,000 passengers at 6 cents average,	$2,400,000
2.	Toll from express, perishable and high-class freights, and from other low-class and through freight to and from New England. (The annual number of loaded freight cars now crossing the river on floats is over 1,500,000, and the number of express cars with New York freight, but not crossing the river, is about 110,000.) 400,000 loaded express and freight cars at an average of $4.00,	1,600,000
3.	Telegraph and telephone wire rentals,	30,000
4.	Rentals from real estate (below the tracks) acquired and necessary for right of way and improved for renting purposes, 3 per cent. net on 3,000,000,	90,000
	Total,	$4,120,000
	Deduct from the above for maintenance, taxes, and other expenses (railroads preferably using their own equipment and crews, and paying their own operating expenses),	820,000
	Balance,	$3,300,000

sufficient to pay 6 per cent. on $55,000,000.

Modern ware and storage houses, similar to those of London, equipped with elevators for moving cars directly from the tracks to the warehouse floors, will reduce to a minimum the cost of handling, distribution, and transfer of freight,—a business indispensably connected with the bridge, joined as it will be to the railroad system of the entire continent. The saving of time and cost in the transfer of about 6,000,000 tons of merchandise will be an item so important to the commerce of the city that a small proportion of that saving for greatly improved service rendered will add vastly to the resources of the Bridge Company.

The North River Bridge is purposely so designed that its capacity may be increased from eight to fourteen tracks, a precaution the necessity of which was taught by the experience with the elevated railroads and the Brooklyn Bridge, which long ago became too small. The addition of six tracks on a second deck, when it becomes necessary, will cost only about $3,500,000, against $40,000,000 for a new six-track bridge with new approaches and right of way.

The brutal crowding in the cars of the elevated railroads and Brooklyn Bridge should not be taken as a standard for transportation capacity. But, assuming ten thousand passengers per track per hour, one-quarter of the passengers may still have to stand up. On special and rare occasions, when extraordinarily large crowds have to be transported, the capacity per track and per hour may reach fifteen thousand passengers.

Of the eight tracks over the bridge two are intended for freight, two for express trains, and four for suburban and local trains with steam or electric power. During commission hours the freight tracks may be utilized also for suburban trains. The capacity of three tracks in, and as many out, would then be available for passenger transportation with a maximum per hour of forty-five thousand passengers. Assuming the number of commission hours to be 5 out of 24, and the traffic of the remaining 19 hours to be equal to that of the 5 commission hours (approximately true for the elevated railroads), then six tracks will suffice to transport from 450,000 to 500,000 passengers per day, or from 165,000,000 to 180,000,000 passengers per year,—a number which will be reached much sooner than it was on the elevated railroads.

Not only, then, may the question whether the North River Bridge will pay be answered emphatically in the affirmative, but the wonder will be that it was ever asked. It is evident, however, that the bridge must be located, first, with reference to local passenger traffic, purely railroad traffic being a secondary matter. Fortunately the location at Hoboken meets both demands equally well.

The existing facilities are ample for the prompt execution of this large work in 4 years with the money ready to pay for it as promptly as the work can be put up,—all of it, for half a bridge is worse than no bridge. It is nothing to the point that the Brooklyn Bridge required three times, and the Forth Bridge in Scotland twice, 4 years. Since their time, very great progress has been made in rapid construction on a large scale, and a great deal depends on a thorough preparation and organization of the work before it is commenced. It can readily be contracted for directly with the largest manufacturers and builders, under proper guarantees, at bottom prices for cash. The project has the further advantage that the legal powers and rights of the company have already been adjudicated in the supreme court of the United States, so that the work may not hereafter be interrupted for long periods by injunctions and law suits. It is well known that delays from that cause have been disastrous to several large undertakings in this country.

THE LIMITS OF ELECTRIC POWER TRANSMISSION.

By Alton D. Adams.

IN every branch of engineering there is a wide difference between the physically possible and the commercially practical, and the electric industry has suffered repeatedly from a failure to recognize this fact. During the past year much has been written which might leave the impression that the electric transmission of power over very considerable distances, up to several hundred miles, is a commercially practical undertaking ; and that power from Niagara Falls or the coal fields of Pennsylvania can be delivered at the large cities of our eastern States at a good profit to the promoter.

The electric transmission of power over various distances up to about 100 miles has been carried out in several cases, but data showing the cost per h. p. year of power delivered over such distances are very scarce. While these long-distance transmissions may form attractive experiments, it must be demonstrated that it is possible to thus deliver power more cheaply than it can be generated at the point of use, before they can become common. The cost of transmitted power increases with the distance, and it is obvious that, assuming absolutely free power at the start, a distance may be chosen great enough to consume its entire value in cost of transmission. To make, then, the transmissions of power commercially practical, it is necessary that the cost of transmission be less than the difference between the value of the power at the starting-point and its value at the point of delivery.

As steam power is the one generally available in cities, its cost may be fairly taken as that which the total cost of transmitted power must not exceed. In the selection of a figure for the cost of steam power in cities, it is fair to assume high-class working conditions, as an enterprise for the sale of power on a large scale would naturally procure the best equipment. When power is to be transmitted electrically, there must be, at the point of delivery, electric motors of the desired capacity, and, at the point where power is available, electric generators of enough greater capacity to make up for losses in line and motors. When very high voltages are employed, it is also necessary to use transformers at the generating and receiving stations, having an aggregate capacity equal to that of motors and generators. A uniform price of $20 per h. p. capacity is a low one to assume for generators, motors, and transformers. A line to connect the apparatus at the generating and receiving stations must also be provided, whose cost will be determined by the special conditions of each case.

An average commercial efficiency of 90 per cent. for generators and motors, and of 95 per cent. for transformers, is a fair assumption ; the line loss will be determined by the conditions of each case. With these efficiencies and no line loss whatever there can be delivered by motors $.90 \times .90$, or 81 per cent. of the power supplied to the generators, when no transformers are used ; or, with transformers, the motors will deliver $.90 \times .95 \times .95 \times .90$, or 73 per cent. of the power supplied to the generators, with no allowance for line loss, which will of course lessen the efficiencies. A case in which it is necessary to deliver 1000 h. p. a distance of 25 miles may be taken as an illustration. It is desirable to use a pressure of 10,000 volts in this case, for economy of line conductor and transformers would commonly be employed to attain this voltage. Allowing a loss of 10 per cent. in line, there must be supplied to the generator $\frac{1000}{.90 \times .95 \times .90 \times .95 \times .90}$ or 1520 h. p., and the generator will deliver $1520 \times .9$, or 1397 h. p. The combined capacities of motor and generator are, therefore, $1000 + 1397$, or 2397 h. p.; adding an equal amount for transformers, we have a total required capacity of 4794 h. p , which, at $20 per h. p., has a value of $95,880. To transmit 1000 h. p. at 10,000 volts 100 miles, at a 10 per cent. loss, requires about 168,700 lbs. of bare copper wire, which, at 12 cents per lb., has a value of $20,000. The cost of a fair pole line, and the erection of the wire thereon across a country where no special impediments to the work exist, would be approximately $400 per mile, making $10,000 for 25 miles.

Summing up these amounts, we have :

Cost of electrical machinery per delivered h. p.	$95.88
“ “ wire “ “ “	20.00
“ “ pole line “ “ “	10.00
Electrical instruments and accessories per h. p.	1.00
Total cost of electrical equipment per h. p.	$126.88

Allowing 5 per cent. for depreciation and repairs, 3 per cent. for operating expenses, including care of line, and 10 per cent. for interest and dividends, we have a total of 18 per cent. of the original cost ($126.88),—that is, $22.83 per h. p. year for transmission expenses.

With well-equipped steam plant, and coal at from $2.00 to $3.00 per ton, the cost of steam power may be fairly taken at $25 per h. p. year of 312 10-hour days and $45 per h. p. year of 365 20-hour days. The transmission-cost of $22.83 per h. p. year very nearly equals this cost of steam power ; so that, under ordinary conditions, for 312 10-

hour days' work, power must be delivered to the electric generators absolutely free to warrant its transmission a distance of 25 miles under assumed conditions.

If power is required for 365 20-hour days, about $20 per h. p. year may be allowed for the cost of power delivered by motor. As shown above, there must be furnished to the generator 1520 h. p. when 1000 h. p. is delivered by motor,—that is, 1.52 h. p. furnished for each h. p. delivered.

Applying this fact to the last case, it appears that for nearly continuous work, which represents the most advantageous condition for the transmission of cheap power, the maximum price of power at generator for a 25-mile transmission must not reach $\frac{\$20.00}{1.52}$, or $13.33 per h. p. year, as the operating expenses of electrical plant are increased by a 20-hour day.

It is certain that, with absolutely free fuel, steam power cannot be generated at less than about $25 per h. p. year of 365 20-hour days; so transmitted steam power, from points where fuel is cheap or even free, is out of the question in the above case.

The cost of water power varies greatly, but it can be procured at some points at less than $13.33 per h. p. year, and this would seem to make the 365 20 hour day transmission commercially practical.

Were it thought practical to employ generators and motors of the necessary voltage, thus avoiding the cost of and losses in transformers, the cost of transmission given above could be considerably reduced, and it is probable that many water-power transmissions from 5 to 20 miles can be profitably carried on with such apparatus.

The above is sufficient to show that the electric transmission of power on a commercial basis is limited to much shorter distances than is generally supposed.

If alternating-current generators and motors, to work at 10,000 volts or over, can be obtained, or if a number of continuous current generators and motors are connected in series to attain the desired voltage, the cost of and losses in transformers may be avoided, and the limits over which transmission is practical considerably extended. It is probable that there are many cases where the transmission of moderate amounts of power from 25 to 50 miles is commercially practical with the last-named classes of apparatus.

There are, of course, special cases, as those of mines among the mountains, where the cost of steam power is excessive, which will warrant a much larger transmission cost per h. p. than that indicated above.

It is sometimes practical to deliver transmitted electric power directly to individual consumers at the receiving station, and thus save the cost of additional generators and motors; this operates to extend the distance over which transmission can be carried on at a profit.

When the transmission of power derived from waterfalls is under consideration, it should be borne in mind that either calculations must be based on the minimum power in the dryest seasons, or else steam power must be supplied to make up the deficiency. This last consideration alone often suffices to render impractical what at first seems a promising opportunity for power transmission.

When the transmission of power from a distance and its distribution for general purposes are under consideration, it should be borne in mind that reliability is the first great requirement of the majority of users. In the early days of electric lighting one of the hardest arguments for the central station manager to answer was that the lamps would and did occasionally go out, in consequence of various accidents to the machinery or line. It is interesting to consider the state of affairs that would exist were a considerable part of New York city deprived of light and power during several hours or a day, while gangs of linemen hurried to some point in the central or western part of the State to repair the supply line, broken perhaps by a heavy storm or washout.

Some of the conditions which combine to render electric service from central stations in large cities reliable are duplicate machinery, underground wiring, frequent inspection, and the accessibility of circuits. These conditions are hard to attain in the electric transmission of power for long distances across country, as the interest on duplicate machines would be a considerable sum, underground wiring would be out of the question because of the expense, and overhead lines across country would be damaged by severe storms.

On the score of reliability alone, it seems doubtful whether any plan for the general use of energy transmitted from a great distance would be permanently successful, for a substantial coal-pile in the cellar would be far more assuring to the average householder, especially in the winter, than a slender wire exposed for 100 miles or more.

It is very evident, however, that all plans for the transmission of power from great waterfalls or of power derived from cheap fuel at the mines, with a view to competition with steam power produced in our large cities, are based on a misapprehension of the facts, and can only result in financial disaster, if attempted. The electrical transmission of power can certainly be accomplished over very great distances when expense is no object, but under usual circumstances it cannot compete commercially with that great vehicle of long-distance power transmission,—an ordinary coal car.

THE PIKE'S PEAK AND COLORADO SPRINGS WATER WORKS.

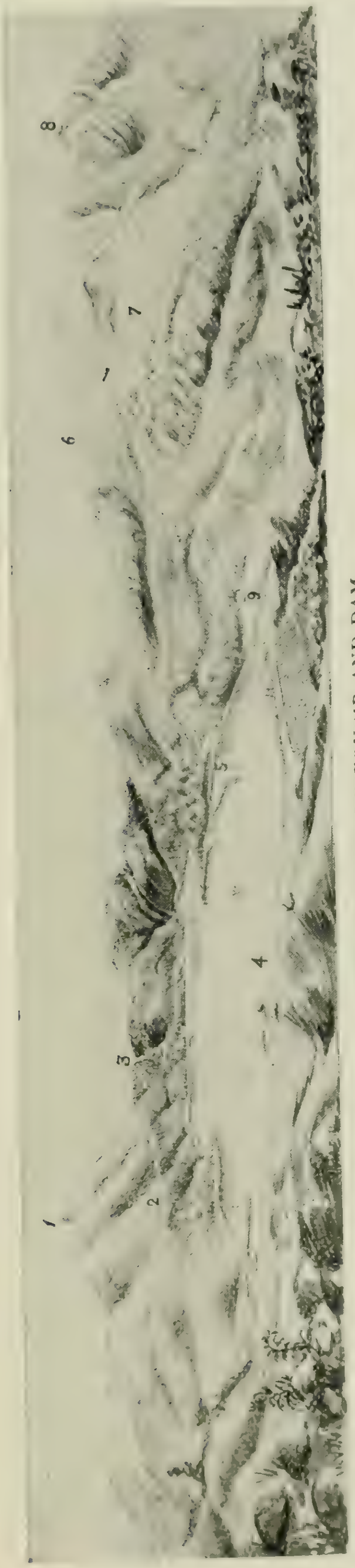
By Arthur Lakes.

THE localities from which many of the cities of the world derive their water supply are among the most beautiful and interesting spots on earth. This is particularly the case when such supplies have their source in mountain regions adjacent to or not very remote from the cities that lie along their borders. These mountain lakes and tarns, often nestling among the highest peaks, fed either directly from the snow or from streams whose source is the snow, provide the purest water imaginable. From a geological point of view these lakes and their surroundings are often full of graphic interest, for in many cases these natural reservoirs have been hewn out by ancient glaciers or have been dammed back by glacial moraines, piles of boulders left by the retreating and melting ice.

The water of mountain lakes is exceptionally clear and pure, because little exposed to contamination by decaying vegetable matter, and often not at all by animal impurities ; and also because these lakes are deep natural settling places for silt and other matters in suspension. Thus the turbid Rhone enters the lake of Geneva full of mud, and leaves it pure, the suspended matter having been dropped in the lake. To increase storage capacity the water line may have to be raised by heightening its barrier at the outlet by an artificial dam. The extent to which the water level of a lake can be raised depends upon the area of the lake, the influx, and the supply withdrawn. Where there is no natural lake, an artificial one can be formed by a dam thrown across a narrow ravine. This reservoir must be formed on an impervious stratum, and be of more or less impervious material. Sometimes the nature of the ground and amount of storage require a series of storage reservoirs at different levels. Six such reservoirs supply Manchester (England) from Longderdale valley in steps, by dams from 70 to 100 ft. high.

The capacity of a reservoir depends on the contour levels of the valley, and the height of the dam retaining it. A small additional height often adds largely to the capacity. High dams are sometimes erected ; that of the Entwistle embankment at Bolton (England) retains a reservoir 120 ft. deep. A dam at Villar Madrid (Spain) is 158 ft. from base to water level, and one at St. Etienne (France) 164 ft. A reservoir dam may be constructed as an earthwork embankment sloping

LAKE MORAINE RESERVOIR BASIN. BEGINNING CONSTRUCTION.



LAKE MORAINE RESERVOIR AND DAM.

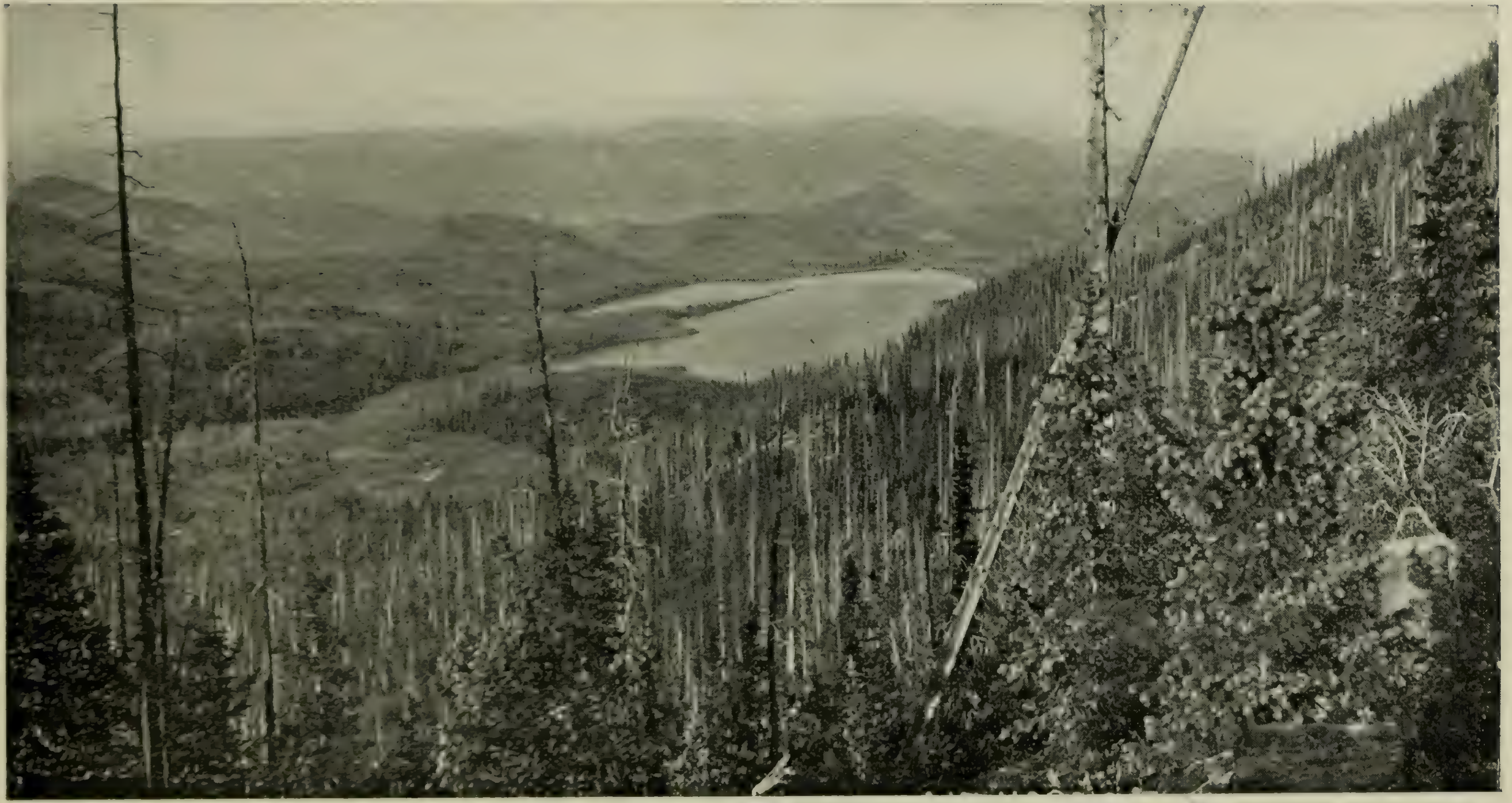
1. Baldy Mountain. 2. Road to Seven Lakes. 3. Pipe from Upper Reservoir Discharging into Lake. 4. Reservoir. 5. Original Moraine and Lake before Reservoir was Enlarged. 6–7. Cog Railroad to Peak. 8. Pike's Peak and Crater. 9. Natural Discharge of Lake.

on each side, with a water-tight puddle of clay. The latter must be carried down to a solid, impervious bed. A masonry dam may be used, if a solid rock foundation is obtainable. Small dams are sometimes placed across the upper end of reservoirs to catch and deposit sediment before the stream reaches the main reservoir.

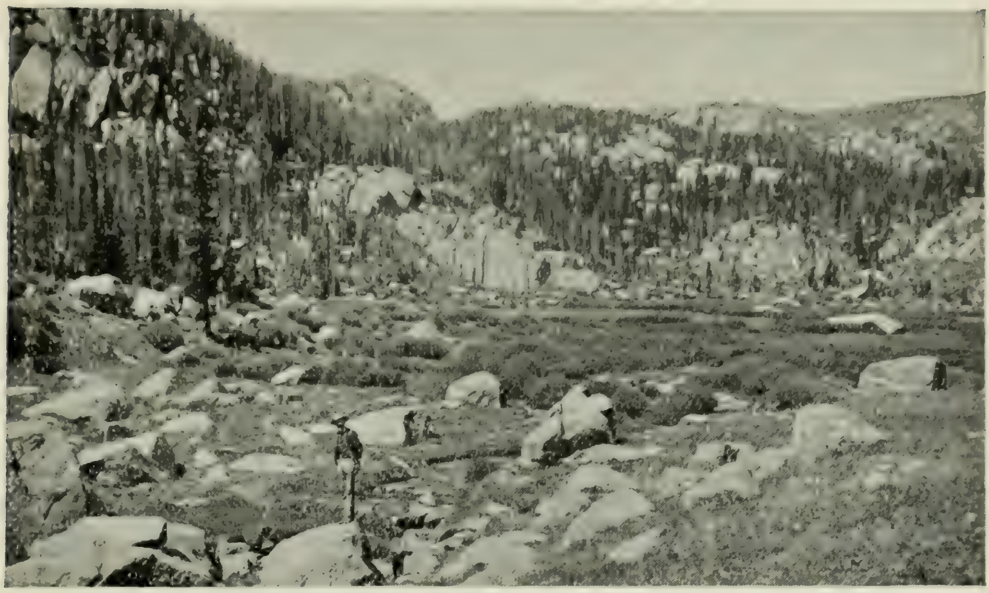
A mountain reservoir discharges by gravitation to the desired locality by canals, tunnels, aqueducts, or pipes. In olden times aqueducts were built; now hills are tunneled and valleys crossed by inverted syphons, and water is conveyed by metal pipes or flumes.

Pike's peak is 14,147 ft. above the sea and about 9000 ft. above the prairie. From its base at Manitou to the city of Colorado Springs is about 6 miles; from Manitou to the top of the peak by the cog railroad, 9 miles. It is a colossal mass of red granite. This is, in general, quite coarse, but towards the summit it is porphyritic and has a finer grain. From a mining point of view the mountain offers few attractions. The massive granite so often exposed in the steep cliffs shows but few veins of a metalliferous character. Owing to the coarse structure of the granite and the oxidation of its mica component, it is subject to rapid superficial decay, and whole mountain slopes are covered with a thick coating of coarse gravel, resulting from superficial atmospheric action.

The summit of the mountain is cloven on all sides by deep ravines, terminating in pits, often occupied by beautiful lakelets. These deep pits are popularly supposed to be "craters,"

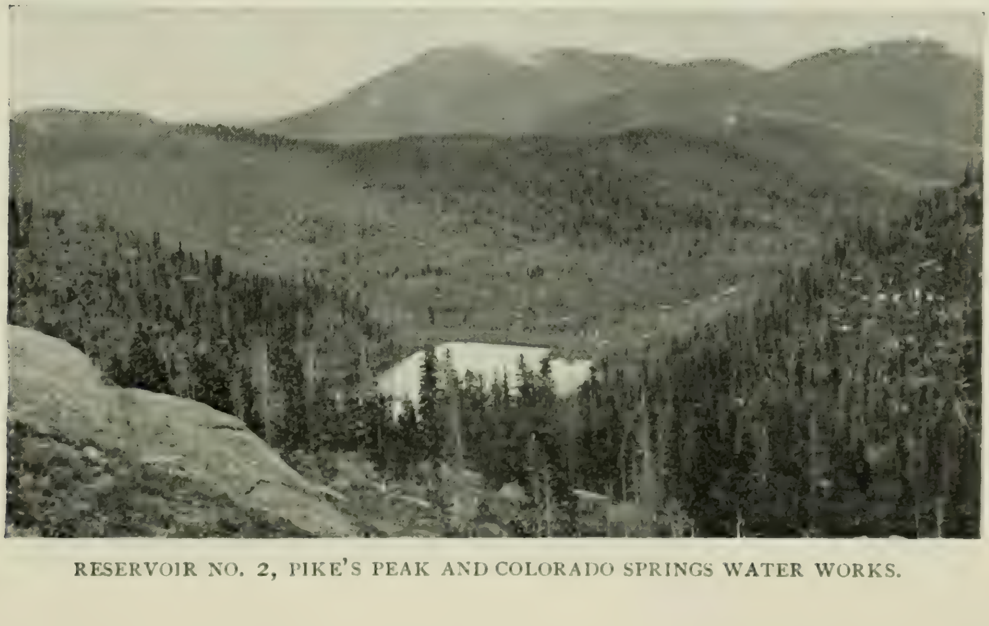


LAKE MORAINE. RESERVOIR NO. 4, PIKE'S PEAK AND COLORADO SPRINGS WATER WORKS.



RESERVOIR NO. 2 BEFORE CONSTRUCTION.

but are in reality only the punch bowl excavations made by glaciers. Though the mountain is doubtless of semi-eruptive plutonic origin, having been extruded from the bowels of the earth at an early period in a semi-igneous state, there are no signs of modern lavas or craters, such as might be expected if at any time the peak had been the seat of a volcano. From these deep pits near the summit long and narrow valleys radiate downwards to the base. The profile of the mountain in some cases shows a descent by a series of steep steps from 500 to 1000 ft. deep, connected by narrow and somewhat level bottomed meadow valleys. Starting from a wide amphitheater about a thousand feet be-



RESERVOIR NO. 2, PIKE'S PEAK AND COLORADO SPRINGS WATER WORKS.

HEAD OF RUXTON CREEK PIPE LINE.

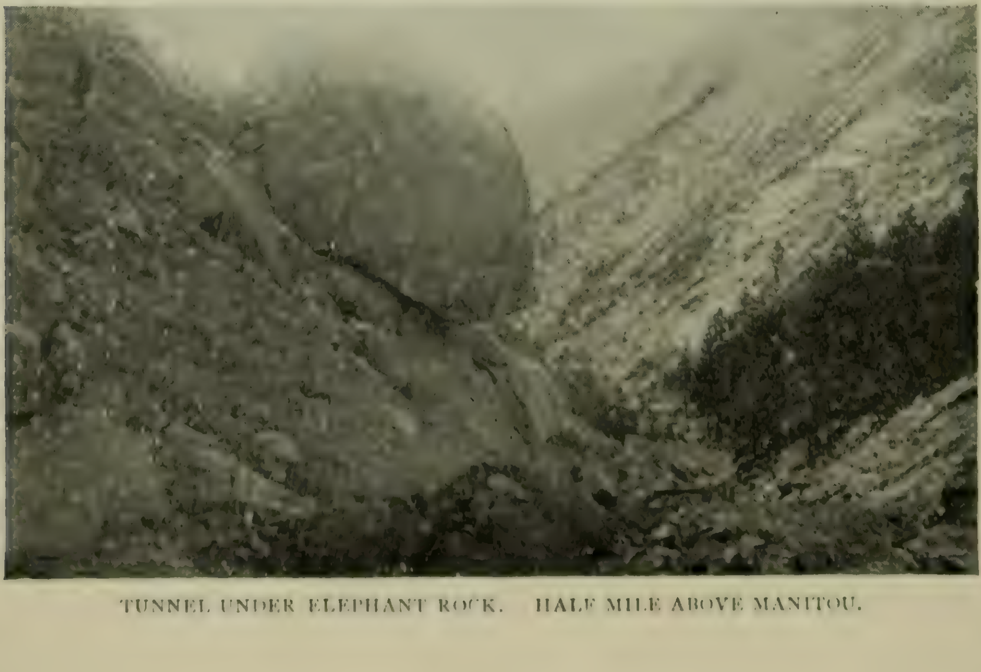
RUXTON CREEK PIPE LINE. ENGINEERS CAMP.

low the summit on the southwest side of the first step is a plunge from this over a steep precipice of granite 500 ft. high into a ravine following the course of Beaver creek. At its head is the highest reservoir at present used, known as No. 2; capacity, 97,000,000 gals. The hills or ridges on either side of this ravine are covered with enormous boulders left by the glacier. Other ravines come in, tributary to this, such as those of Boehmer and Sackett creeks, each with its local lake or natural reservoir near the head of its ravine. Following the valley of Beaver, it comes to an end in a *cul de sac* under Bald mountain,

RUXTON CREEK PIPE LINE, AT "HALFWAY HOUSE."

BOEHMER CREEK INTAKE.

where there are congregated upwards of seven beautiful bodies of water known as the "Seven Lakes," occupying basins among the moraines left by the glacier. From this point there is no open outlet to drain the lakes into Lake Moraine. To accomplish this a tunnel about 2500 ft. would have to be made through Mt. Baldy; but a short distance up Beaver creek is a comparatively low pass 100 ft. above the valley of Beaver, called the Seven Lakes divide. From this another great step descends 1000 ft. into the deep wide ravine occupied by Lake Moraine. Lake Moraine proper is a beautiful little



TUNNEL UNDER ELEPHANT ROCK. HALF MILE ABOVE MANITOU.

piece of water, covering about 20 acres, formed at the east end of the outlet of the ravine by a circular moraine left by the glacier. At one time the whole valley was occupied first by a glacier, and later by a lake over a mile in length, dammed back by a wide moraine thrown right across the valley ; but at some time this principal moraine was broken through, and the water of the lake was discharged down a steep narrow ravine along the path of what is called Ruxton creek, leaving only the small circular lake behind it. Lake Moraine and its enlargement constitute the next and main reservoir. In the ravine below the lake there are ample evidences of the pathway of the glacier in cliffs of granite on either side rounded into *roches moutonnées*, or glacial "sheep backs." Thence the stream bounds unchecked down Ruxton cañon over huge boulders and in sparkling cascades to Manitou, where it joins Fountain creek and eventually finds its way to the Arkansas river. Though there are other ravines and creeks from Manitou, such as Bear creek and Cheyenne creek, which are made to contribute their waters to the Pike's peak supply for Colorado Springs, yet it is along the creeks mentioned and the course we have outlined that the main drainage system of the mountain and that used for reservoirs is located.

The peak itself would seem to be the "father of waters," although it retains in summer but little of the snow which covers its surface in the winter, and is snow capped but for a day by a passing storm. Yet, if we descend the west side a few hundred feet over a deep mass of angular boulders and listen, we hear, seemingly within the mountain, like the *vox humana* of a distant organ peal, the voice of many unseen waters, which find their way below the thick, loose *débris* into the wide Amphitheater on the southwest face of the peak.

This great Amphitheater was evidently the gathering ground of the great ice mass from which, when the basin overflowed, glaciers descended into the lower lands. It is now the principal watershed of the peak and of its drainage system. The bottom is dotted with lakelets, occupying basins formed of morainal *débris*. These basins sometimes communicate with one another by rills, and in the largest the principal branches of Beaver creek have their source, one branch flowing southwest in the direction of Cripple creek, and the other over the step we have described to Seven Lakes, receiving on its way various tributaries.

The marks of the great ice mass are very apparent on the Amphitheater. All red granite bosses are rounded into smooth "sheep backs," and the bottom is strewn with morainal boulders and circular basins of morainal *débris* occupied by the lakelets. Where the ice mass slid over the steep cliff into reservoir No. 2, the rocks are planed down as by a giant plane. Doubtless at this point crevasses opened in the ice, as they are wont to do when the ice passes over a precipice.

There is nothing in the way of animal life to sully or contaminate the ethereal purity of the water of this mountain valley save the few wild denizens of the place—the marmot, the coney, the mountain ptarmigan, the eagle, and an occasional deer. This great Amphitheater is at present not much used as a reservoir, but in the near future there probably will be stored in it a large body of water by damming up the outlet of the fork of Beaver flowing southwest, as well as by opening communication between the various lakelets. The capacity will be more than 525,000,000 gallons. To get this water out of the Amphitheater will require some engineering skill. The work will be begun next fall by Mr. H. I. Reid, the city engineer of Colorado Springs. He has three plans in view. One is to run a tunnel from the Amphitheater, 5000 ft. long, down into reservoir No. 2; another is to carry the water by a flume 5 miles long by a roundabout course among the cliffs and hills; and a third, the one preferred as cheapest and most novel, is to pipe the water from the end of the timberline flume already constructed to reservoir No. 2, the force to be derived from a Pelton impact wheel, which will generate electric power to be transmitted by wire back to the big Amphitheater reservoir, or reservoir No. 8, and pump into the timberline flume. By this means there will be a capacity for pumping into the flume 5,000,000 gallons per day. A considerable portion of the general water supply already comes through this timberline flume, which was built originally rather to hold the ground against competitors for rights in the great reservoir. It was built just above timberline on the east fork of West Beaver, 1 mile west of the summit of the peak, at an altitude of 11,900 ft. above sea level. The flume is 4000 ft. long, and traverses the lowest pass between Beaver and Middle Beaver, whence it flows down the natural channel of the latter stream over the precipice to No. 2 reservoir. Below the reservoir it continues in the channel of Middle Beaver for 1½ miles, and is thence diverted through the McShane ditch and the Beaver creek pipe across the Seven Lakes divide, falling over a steep cliff 800 ft. high into the Lake Moraine reservoir. Thence again, by pipe and fall and ditch, down Ruxton cañon to Manitou, and again by pipe to the reservoir on the mesa a few miles west of Colorado Springs; thence by pipe, with a fall of 200 ft., to the hydrants of Colorado Springs. As there is a total fall of 5874 ft. from the highest reservoir to the plains, no continuous pipe of large size—at least, none built at reasonable cost—could stand such a pressure; hence the necessary and natural interruptions and breaks by intermediate reservoirs, falls, cascades, and open ditches.

Until 1878 the town of Colorado Springs had no water system. People drew their water from deep wells or open ditches. The soil under the town is so loose and porous that contamination occurred, followed by typhoid fever. The pure waters from the cañons of Pike's peak were looked to, and in 1878 a gravity system was constructed, bringing water from Ruxton creek above Manitou through 6 miles of 8-in. pipe to a reservoir on the mesa west of the town, whence it was distributed through the mains.

This supply was sufficient until 1889, when the growth of the town demanded additional flow. A 16-in. pipe was added from Ruxton creek, the waters of Bear creek were drawn into the system, and a ditch (now a pipe-line) was constructed to make the waters of Cheyenne creek also tributary. All was then supposed to be settled and safe. But in Colorado the right to take water from a stream is as much property as land ; and a large land company having prior rights on Fountain creek (to which Ruxton and Beaver creek are tributary) brought suit against the town, resulting in depriving it of all rights on these tributary creeks, the law reading that "the water of tributary streams was included in the water rights held on the main stream." (The town purchased old rights on Beaver creek for domestic purposes and rights on Fountain creek for irrigation supply, paying $70,000.) The town, therefore, had to look elsewhere for its water supply, and an original idea was conceived for a supply which would involve no litigation. The high range 10 miles west of town becomes very cold in winter. The plan was to run a flow of water by pipe or ditch over a declivity during the winter season, which would pile up a huge mass of ice that could be thawed gradually in the summer. It was called the "iceberg idea," and, as it is unpatented, may be a suggestion for other places similarly situated. Congress in 1889 granted Colorado Springs a tract of 700 acres, including the site of Lake Moraine, for reservoir purposes. This basin of 90 acres was too high up for the pollutions of civilization to settle above it. Here was a natural dam, with only a narrow and easily-repaired break in it. In the bottom of the smaller or original Lake Moraine were two powerful springs, while the immense basin adjacent could be filled by building a small dam, and thus be made to yield an ample supply. Work was accordingly begun the same year and the dam built, 385 ft. long, 250 ft. wide on the bottom, and 20 ft. wide on the top, with facing of granite 3 ft. deep on the water face and 2 ft. deep on the outer face. It has a slope of 3 to 1 on the inside, and 2 to 1 on the outside. It is an earthen dam made of clay and gravel faced with stone. The side facing the water does not start directly down, but has a step called a "berme" to accommodate the granite riprapping. As the filling in of the earth progressed, two strips of puddling of clay were built up, which, as the clay hardens, becomes impervious. Each of these strips is 15 ft. wide and extends 14 ft. below the bottom of the dam. The dam itself rests on a bed of clay, which was pierced to a depth of 35 ft. without finding bottom. When filled, the reservoir will extend back nearly a mile, and will rise to within 7 ft. of the top of the dam, overflowing through the natural spillway. This natural waste weir is a great local advantage, allowing the water to flow off 600 ft. to one side when it reaches a certain height instead of overflowing the dam itself. The waste pipe is 280 ft. long, placed in the natural earth and buried in a bed of concrete and hydraulic masonry. At the triangle in the pipe is the valve for turning on and off the water. The cost of the dam was $22,000.

Climbing the cliff at the head of the basin of Lake Moraine, we come out on the narrow ridge called the Seven Lakes divide, 11,070 ft. above sea level, and look down on one side on the lake 1000 ft. below, and on the other to the Meadow valley and stream of Beaver creek 100 ft. below. This stream starts on the side of Pike's peak, and through narrow ravines flows down to join the Arkansas river at Cañon City. Its flow is large, clear, and constant; and, as the height of the divide was comparatively low, a ditch was constructed to bring the waters over the divide by a pipe and discharge them over the precipice into the basin of Lake Moraine. The tributary streams of Boehmer and Sackett creeks were also enlisted in the same service. The mouth of the pipe is several feet below the surface, so that it will always be filled, no matter how cold the weather and thick the ice. The cascade at the lower end of the pipe may freeze in winter and test the "iceberg idea." The pipe carries 5,000,000 gallons daily. The head of this system on Beaver creek is at an altitude of 11,800 ft. Profiting by past experience, the legal rights on Beaver creek were secured, and the legislature granted cities certain rights for taking the water from one watershed to another. This gives Colorado Springs 12,000,000 gallons per day. The present consumption is 3,000,000 gallons. The "timberline reservation act" secured the region about the peak from settlement, and protected thereby the water supply from pollution; but this did not extend to Ruxton creek, so a 16-in. pipe was laid to carry the water from a point 1 mile below Lake Moraine.

The town storage system holds 604,000,000 gallons of drinking water and 500,000,000 gallons of irrigation water. Lake Moraine contributes 492,000,000 gallons of drinking water. Its high altitude and living springs prevent it from becoming warm or stagnant.

The two reservoirs on the mesa hold 1,000,000 and 15,000,000 gallons respectively, but the principal irrigation reservoir is Prospect lake, in a natural hollow east of the town, holding 374,000,000 gallons.

There are several other auxiliary systems, not connected with those of Pike's peak. The total amount expended hitherto on the Colorado Springs water supply is $525,000.

Sunshine and rain are both needed for green grass and shady trees and bright flowers, which go with the scenery to make Colorado Springs the handsomest resort in Colorado. The climate gives too much sun in proportion to rain. The irrigation of gardens is by hose and ditch. Water also runs in ditches along the sides of the streets, keeping fresh the shade trees which so much add to the beauty and coolness of our western towns.

The time may not be far off when, owing to the rapid growth of the city, still further enlargements of the water supply may be necessary, in which case it has still the waters of the Seven Lakes and those in the great Amphitheater west of the peak, both of which could be brought, as we have shown, into the general reservoir of Lake Moraine through the medium of tunnels. There are several other small and at present isolated bodies of water in the different crater-like pits, which, under the skilful engineering of Mr. H. I. Reid (to whom the planning and engineering of the whole water system is due), could be brought into the common system.

THE MASSACHUSETTS RAILROAD COMMISSION.

By William A. Crafts.

AFTER the civil war, when railroads were being extended in every direction to meet the wants of multiplying industries and the increasing demand for intercommunication, and the dependence of numerous interests on these highways and on the manner in which they were operated was recognized more generally than while the war engrossed public attention, there arose a demand for some governmental control or supervision which should hold the corporations to a full performance of their duties and secure reasonable and equal terms and facilities to all persons. Laws had been passed regulating them in some respects, but it was left in a great measure to the discretion of the managers to determine to what extent the laws should be obeyed. The corporations had become powerful, and inconsiderate of any interests except their own. It was the privilege of parties who suffered to seek redress in the courts for violations of the law,—a process usually avoided because of expense, trouble, and delay, except in cases of great pecuniary importance. Moreover, the railroads were under certain obligations to the public, and owed certain duties, not specifically prescribed by statute, which they theoretically recognized, but for the neglect of which there was no legal penalty. Managers of railroad corporations had done some extraordinary and scandalous things, to the great damage and even ruin of the interests with which they were entrusted, as well as to the injury of the public weal. This condition of things had gone on, practically drifting, attacked at intervals through the press, and partially modified by laws, till there came at last a demand for the exercise of some authority over a business on which all other interests depended.

The railroads had their charters from the States and were under the laws of the State in which they were constructed, and to the State belonged the right and duty of supervision within its territory. It appeared to be most in harmony with the structure of our older State governments that this supervision should be exercised through a board or commission. Massachusetts took the lead in establishing such a commission in 1869. There had previously been railroad commissions in two or three States for special purposes, chiefly in relation to location and construction over highways, and with very limited powers; but Massachusetts was the first to establish a commission with authority to exercise a general supervision of the railroads of the State. It was a commission with wide jurisdiction, extending from the financial condition of the corporation to the construction and operation of the road and its service to the public. It could investigate, report, and recommend, but it had no direct power either to enforce the laws or to compel compliance with its recommendations.

Several States soon followed the example of Massachusetts, establishing commissions for the supervision of railroads and substantially on the same model, with such modification as the existing railroad laws rendered necessary or expedient. But this model was not adapted to the transportation conditions and the temper of the people in a large part of the country. They demanded more heroic remedies for existing or alleged evils,—State control instead of State supervision. The Granger movement swept away the milder form of supervision, and the State commissions throughout the west and south have the power to control the railroads in some of their most important functions. In most of those States there have been constant friction between the commissions and the railroads, complaints of unequal service and exorbitant charges, and repeated demands on the part of individuals or sections for reduced rates or better facilities. The establishment of the Interstate Commerce Commission transferred many of those questions to that tribunal, but local questions still fret the State commissions, and neither railroads nor shippers nor travellers nor the commissions are satisfied.

In Massachusetts, however, the milder form of supervision was not changed, and for more than 25 years the commission, with constantly increasing duties and slightly added power, has continued to serve the public and the railroads. In no State during that time has there been less friction between the railroads and the public, or, on the whole, more satisfactory service by the railroads.

This condition of affairs, while not due wholly to the existence of the railroad commission, has been greatly promoted by it. The law establishing the commission was not hostile to the railroads, or unreasonably exacting ; indeed, it commanded the approval of some of the most prominent railroad managers. But at that time in Massachusetts, as elsewhere, there was considerable agitation in some communities concerning rates and facilities for freight and passenger traffic, and there were charlatans who were advocating crude and drastic measures for the reform of railroad methods and practices. The passage of the law establishing a commission, therefore, was for the moment a check to unwise and crude legislation or attempts at legislation, and, when once created, the commission itself, by argument and report and personal influence, prevented the passage of such measures.

The commission, from the character and antecedents of its members, soon gained the confidence of the public, and gradually in a great measure that of the railroad managers. The civil service of Massachusetts, especially in its higher appointive offices, has been free from the control or attack of the spoilsmen to a greater degree than in most, if not all, the other States. The members of the commission were not elected by the people, and were not representatives of a party, as in some of the States, but were appointed by the governor, not as partisans or politicians, or as a reward for party service, but on account of supposed qualifications for the place. The theory of the advocates of the commission as to its composition, though not embodied in the law, was that one member should be a lawyer, one a merchant, and one a civil engineer, and two at least of the number were the common choice of the advocates and framers of the law.

It is not the purpose of this paper to eulogize individual commissioners or to narrate their special services, but, as the first commission laid the foundations for the service and reputation of the board, it may be well to refer more particularly to its members. Mr. James C. Converse, a merchant of Boston and president of the board of trade, was elected chairman, but Mr. Charles Francis Adams, who succeeded him three years later as chairman, was from the first the leader in the commission. He had given the "railroad problem" considerable study, and was known as an able writer on railroad questions. He practically formulated the policy of the commission, marked out its work in great measure, and wrote its decisions and reports. He discussed general railroad questions with an ability that secured a reputation in the most intelligent railroad and business circles. He entertained theories with sufficient enthusiasm to try to have them put in practice, but he was a student, and did not hesitate, upon obtaining further light, to change his views. Under Mr. Adams's lead the commission was progressive, desiring that the railroads of Massachusetts should not lag behind the best roads of other States in any respect. It advocated the reform of existing bad policy or practice, and the adoption of improved methods and ideas. By investigation and discussion it aimed to educate the public as well as railroad men, and by publicity to bring public opinion to bear upon the errors and defects of railroad management, and the improvements which were desirable. Complaints and petitions were listened to and both sides patiently heard, and decisions were reached after careful weighing of evidence and without prejudice. A complete presentation of the reasons for the conclusions generally secured an acquiescence in, if not a full approval of, the decision. Pursuing such a course for 10 years, ably supported and assisted by his colleagues, who were men qualified for their position, Mr. Adams may be said to have given the commission its direction, and in great measure to have established its reputation. It had the confidence of the public and the respect of legislators, except of that class found in all legislative bodies who consider their own uninformed snap judgment worth more than the carefully-studiedop inion of experts.

When the commission was established, none of the railroads of Massachusetts were noted for adopting improvements in construction and equipment. They were in fairly good condition in both respects, and the principal lines were above the average of the roads of the entire country. One or two were experimenting with steel rails; one only had adopted the Miller platform and coupler; none had tried air brakes. The very first year of its existence, the Revere disaster—one of the worst accidents that ever occurred in Massachusetts—gave the commission opportunity and cause to urge upon all the railroads the expediency and necessity of adopting improvements in equipment and practice which had been tested elsewhere, and the absence of which in this accident had proved so fatal to human life and so disastrous to the corporation.

From that time on the commission has earnestly and forcibly advocated the adoption by the railroads of all well-approved appliances to secure the safety of travellers, employees, and the public at large, and has presented the matters in such a light that its efforts have been endorsed and supported by public opinion, which in turn had its effect eventually on the most conservative railroad managers. Without enumerating the various improvements advocated by the commission, the following are some of the more important secured thereby at an early day: the automatic block system, continuous or train brakes, tools in passenger cars for use in emergencies, the abolition of common stoves and heating of passenger cars by steam from the locomotive, and the establishment of interlocking signals and switches at grade crossings of railroads and at terminals. Some of these, by reason of the earnest advocacy of the commission, were required by legislation subject to its approval. To the credit of some of the railroad managers of Massachusetts it may be said that, when once persuaded or required to adopt such improvements, they determined to "get the best" and made liberal expenditures in doing so.

In this connection reference may be made to the efforts of the commission to secure congressional legislation in regard to safety appliances on cars used in interstate commerce. It was evident that, owing to the interchange of rolling stock in the through traffic of the country, nothing in the way of such improvements could be accomplished by any single State. The subject accordingly was brought before the convention of State railroad commissions by the Massachusetts commission. Through its efforts, seconded by the commissions of other States, many State legislatures adopted resolutions requesting congress to take action on the subject. This brought the matter directly to the attention of many members of congress, and interested some of them sufficiently to keep it before that body till at last, in 1893, a federal law was passed requiring, after certain dates, that all freight cars used in interstate commerce should be equipped with automatic couplers, that all freight trains engaged in interstate transportation should be equipped with train brakes operated from the locomotive, that the locomotive should have power-driving wheel brakes, and that each freight car should have hand-holds or "grab irons" for the safety of employees.

For many years previous to the establishment of the commission the railroads had been required to make annual reports of their condition and operation on blanks furnished by the State, the items in which were prescribed by law. On examination of these reports to ascertain the condition of the companies individually and collectively, the commission found, not only that their form was defective, but that they were utterly worthless for comparison of one road with another and for compilation of general results and averages. The system of bookkeeping appeared to vary according to the policy or necessities of the company. One company had been in the habit of charging new rolling stock, built or purchased to replace old, to operating expenses, so that, at a time when locomotives were costing $10,000, their locomotives stood on their books at an average cost of $2000 or $3000. Another company would adopt a policy the reverse of this, and charge to construction items which belonged to operating expenses.

It was not altogether an easy matter to reform the methods of bookkeeping which some of the old railroad officials had been following for many years. But, by changing the form of the report, and showing the unfairness of comparing results shown by different systems of bookkeeping, something was accomplished, and subsequently, under the supervision of an expert accountant, the returns were brought to a fair degree of correctness and reliability. The advantage of this is now fully appreciated by those officials who were at first loath to abandon old habits. It was an important advantage to the commission, as it gave them a fairer knowledge of the actual as well as comparative condition of the several roads, which knowledge is often of absolute importance in determining questions that arise in the performance of the duties of the office.

While the success of the Massachusetts commission is due chiefly to the legislation of the State in determining its functions, and to the character of its *personnel*, it was fortunate in the beginning that there was not in the State any overshadowing railroad corporation to antagonize it, or any one great predominant interest opposed to alleged exactions of the railroads asking the commission to right its wrongs. At the west, where agricultural products form the great bulk of railroad freight, the agricultural interest, the consolidation of all the individual grain growers and cattle raisers into one body to which all other interests are subordinate, is a power in business, and especially in politics, which is arrayed against the railroads, whose interests are supposed to be adverse. It is not necessary to consider how much of this hostility is well or ill founded; the fact is that it exists. And that is why there were "Granger laws" in the place of railroad supervision, and a perpetual war against railroads instead of moderation and conciliation.

In Massachusetts, as in other eastern States, on the other hand, there is no one predominant interest contending with the railroads for one definite purpose,—better and cheaper facilities for transportation of its products. The only thing that partakes of that character is the manufacturing interest, which, of course, wants cheap transportation, especially for its crude materials,—cotton, wool, iron, and coal. But the manufacturing industries are so various, and the conditions under which they exist are so different, that there can be no universal demand for a uniform redress of alleged grievances. Moreover, the combined manufacturing industries furnish only a fraction of the business of the eastern railroads. The grievances as to rates are therefore individual or local, and, as such, demand special methods of redress; and to fix a uniform rate for the transportation of certain classes of freight, if not utterly impracticable in Massachusetts, would result in manifest irregularity and injustice to some of the interests concerned. Each application for a reduction of rates has, therefore, been heard by the commission on its merits, the charge generally being either discrimination or exorbitance, and, after a careful weighing of the evidence and the application of certain admitted principles, a decision has been reached and presented with such fairness and weight of argument that in most cases it has been acquiesced in by the party against whom it bore. If a railroad refused to comply in any degree with the recommendation of the commission as to rates, the aggrieved party could apply to the legislature to fix the rates. In only one case of any importance, however, has there been such refusal, and that was by a foreign corporation that operated leased roads in Massachusetts. The parties aggrieved by the railroad's refusal resorted to the legislature, and the commission by special act was authorized, after a further hearing, to prescribe the rates, which were then subject to enforcement in the courts.

The commission has never desired the power of establishing rates, and has more than once advised against proposed legislation increasing its powers in that or any other direction in a way to disturb the natural course of business. Early in its history it found that a gradual reduction of rates was brought about by the competition of railroads, business centers, and industries, and from year to year it showed this reduction in its annual reports. Improved facilities for traffic in the way of construction and equipment, and wise economies resulting from an intelligent use of experience, were believed to produce a more natural and safe reduction, even if slower, than any governmental regulation could effect. The efforts of the commission were, therefore, directed to bringing about such improvements and economies as the true basis for the lowest paying rates.

How reduction of rates resulted, under this policy on the part of the commission, and through the natural forces of commerce and industries, may be seen by the following statement. In the first year after the creation of the commission the average freight rate per ton mile on all the Massachusetts railroads was 3.11 cents, and in 1894 the average was 1.33 cents. On two roads connecting directly with the west the rate on one in 1870 was 2.19 cents and in 1894 .94 cent, and on the other the reduction was from 4.81 in 1870 to .90 cent in 1894. The average reduction is, of course, largely caused by increased volume of through business on which the rates are exceedingly low; but the local rates have also gone down under the natural laws of trade, though they do not operate with equal force in a limited territory.

In the matter of accommodations and facilities the commission has had a great many cases which have been heard with impartiality and due regard to the condition and business of the railroad as well as the interest of the community it served. In several cases where the commission recommended new or better station buildings and the railroads concerned neglected to comply with the recommendation, recourse was had to the legislature (not by the commission, but by the parties aggrieved), and acts were passed requiring the road, under a penalty for delay, to construct such buildings as the commission should prescribe. In performing these duties the commission required only what was needed to meet the wants of the local business, present and immediately prospective, and the extravagant wishes of some of the patrons of the road were overruled. The result has been that the local communities have been fully satisfied, and the railroad managers have generally acknowledged that in these matters they have been fairly dealt with by the commission.

The Massachusetts commission has supervision of the street railways to a certain extent. It prescribes the form of the annual report of the financial condition and operation of the railways, and the method of bookkeeping. The location of tracks and appliances for motive power is mainly under the control of municipal authorities, subject, however, in some cases to the approval of the commission. The use of electric motive power has multiplied the number of street railways all over the State, and especially in the eastern part, where the population is dense. New companies have been organized, and these consolidated with older companies connecting with them. Such consolidations offered great opportunities for stock watering and other abuses. Recent legislation, however, has provided a check to such operations. No railroad or street railway can increase its capital stock or issue bonds except with the approval of the commission; even when authorized by the legislature, new stock and bonds can be issued only under such approval of the commission, after a careful investigation of the financial condition of the companies and the purposes to which the stock and bonds are to be applied. The commission has been careful in its examinations, and fearless in condemning whatever appeared to be of questionable honesty or doubtful policy. This has proved a salutary check upon the schemes of outside syndicates or "traction companies" organized in other States to get possession of Massachusetts street railways and issue securities far beyond their value.

The Massachusetts commission has the reputation of being the ablest and most successful of the State agencies for the supervision of railroads. That reputation is due, in the main, to its able reports and discussions of railroad questions, and to the absence of any conflict between the railroads and the public. Such real success as it has had may be attributed to the following causes and conditions:

1. The railroad code of the State—in its present condition due to a great extent to the commission—was such, at the outset, as to make a commission a logical step in the administration of the laws. From the beginning of railroads the State had reserved the right to alter or amend the charters, and to subject them to all subsequent laws. The commission was therefore recognized by railroad managers, as well as by the general public, as a legitimate supplement of existing laws.

2. The theory of the duties and functions of the commission, as conceived and formulated by its early advocates and continued to the present time, was simply to ascertain and report whether the laws were obeyed, and if the roads were fulfilling their obligations to the public. By its discussion of questions arising in the performance of these duties, it was to guide, mould, or create public opinion, and bring it to bear upon railroad managers. The limitation of its powers made it more acceptable to the corporations, and eventually satisfactory to that portion of the public which desired to give it greater power.

3. The *personnel* of the commission, except for one brief period, has been free from political control or partisan appointment. The members have been men of ability, who commanded the respect of the people, and, in the main, of railroad managers. They have held the position continuously, by reappointment, for a long time, three of them until their death, and one, who declined reappointment, dying shortly after the close of his second term of 3 years. This permanence of official life has given it the advantage of continuous study and experience.

4. The conservative, careful manner in which it has heard and acted on questions arising between the railroads and the public or individuals. Much of its work has been of a judicial character, and it has maintained an impartial and dignified attitude in its conduct, and in its reports, decisions, and recommendations. It has not attempted to prescribe the duties or the policy of the railroads beyond the requirements of law fairly interpreted; nor has it hesitated to condemn what it considered unwise railroad policy or bad railroad practice.

5. The generally wise and moderate legislation of the State. This is due in no small measure to the advice and influence of the commission. By that influence some unwise, not to say foolish, projects have been kept from the statute book, and measures of good intent have been perfected. The legislature, by its committees, has fully consulted with and deferred to the commission, and, in imposing new duties on the railroads, has in many cases made them subject to the discretion of the commission.

6. The absence of any popular demand resisted by the combined railroads of the State. The questions at issue have generally been between a particular community or class and a single railroad, and, though the principles evolved might affect other communities or railroads, each case has been decided on its merits.

So long as the commission exists under these conditions, it will continue to be successful in promoting the interests of the public and the railroads. When it is made the State's agent for control or management, it will cease to be useful.

FRANKLIN LEONARD POPE.

WARM personal esteem and friendship, combined with the respect which conspicuous talent, practical ability, and rigid integrity always command, render it a grateful task to pay that tribute to the character and work of Mr. Franklin Leonard Pope, late of the staff of THE ENGINEERING MAGAZINE, for which his recent sad and sudden demise furnishes the occasion.

In a recent conversation with Mr. Pope the subject of the various forms in which death approaches was discussed, eliciting from him the expression of a hope that his own death would come by no lingering route, but quickly and painlessly. He did not fear death,—no man like Mr. Pope need fear death,—but he confessed to a dread of the suffering, often prolonged for weary months and years, through which the end of life is at last reached. To retain health and mind in full vigor till the appointed time, and then to glide out "into the unknown region where there is neither sight nor sound, nor any path to follow," seemed to him "a consummation devoutly to be wished."

He completely realized this wish. Death came to him invisibly, swiftly, painlessly, and silently,—like a chance arrow in the night,—before his physical or mental powers had known any impairment, and in, perhaps, the crowning moment of his useful career, at his pleasant home, and while surrounded with his family and all that makes life pleasant and desirable.

Born in Great Barrington, Mass., in 1840, Mr. Pope returned about 2 years ago to the place of his birth, and resided there as a distinguished and honored citizen of that beautiful town. He was the consulting engineer of the Great Barrington Electric Light Company, and—characteristically—took great interest in his work.

To afford convenient opportunity for observing the operation of the plant, he had placed in the cellar of his house the two 1000 volt converters connected with it. On the appearance of any trouble with the lights that was attributable to this part of the apparatus, it was his custom to personally make any needed adjustment. On the fatal evening of October 13 something appeared to be lacking in the operation of the converter, and Mr. Pope went down to make the adjustment. In a few moments his family, on the floor above, heard a heavy fall, and, going to ascertain the cause, found Mr. Pope dead on the cellar floor. His death seemed to have been instantaneous, and was, doubtless, without pain. It is supposed that he received a fatal shock from the current, said to have an electro-motive force of about 2000 volts.

Exactly in what way this skilful electrician, versed in all the details of electrical machinery and apparatus, and fully aware of all the danger of carelessness or inadvertence in manipulating a converter, became exposed to an electric shock will probably never be known, unless medical examination shall disclose the fact that some sudden physical disability came upon him and deprived him of the power to apply his usual care, knowledge, and prudence to self-preservation.

At the age of 17 Franklin Leonard Pope commenced his career as an electrician in the humble capacity of a learner of telegraphy in the office of the American Telegraph Company in Great Barrington, where he mastered both the Hughes printing telegraph and the Morse telegraph systems, becoming an expert operator.

At the age of 20 he came to New York, and, looking around for employment, called at the *Scientific American* office as an applicant for work. With a single exception—Horace Greeley—there probably never came to this city a talented youth less calculated by exterior appearance and cultivated manners to win favor at sight than was Mr. Pope at the time he made this application. Yet, without knowledge of the world's ways, without anything to recommend him, except a gleam of talent, which, like the glint of a diamond in the rough, revealed his true quality, the youth, in this field of push and hustle, stood his ground and made his way. He first tried his hand at drawing in the office of the *Scientific American*, but, having a native bent for writing (in after life greatly developed), the shrewd managers of that newspaper detected his latent capacity, and gave him work in the editorial department.

Near the close of the great civil war a project for uniting this country with Europe by wire, by what was styled the "Collins route" through British Columbia, Alaska, Russia, and Siberia, was projected. The Western Union Telegraph Company spent $4,000,000 toward carrying out this scheme, abandoning it when the first ocean cable demonstrated the feasibility of communication directly across the Atlantic. In the necessary surveys for this work young blood found, and seized upon, opportunity. Among others, Mr. Pope, a vigorous young man of 25, proffered his services, and obtained a position as engineer on the staff of Colonel Charles T. Bulkley, who was at the head of an exploring expedition in British Columbia and Alaska for the purpose of locating a practicable route. In this service Mr. Pope made the acquaintance of Mr. George Kennan, the author of a series of articles on Siberia, published in *The Century Magazine*, and subsequently printed in book form. A friendship formed between these comrades through two years of service and based on mutual esteem for sterling qualities which each recognized in the other, was never broken.

In 1868 Mr. Pope returned to New York and assumed the editorial conduct of the *Telegrapher*. While editing this paper, he published "Modern Practice of the Electric Telegraph," a standard treatise, without which no electric engineer's library is complete. His attention then turned to the subject of electric railroad signalling, and he engaged in the signal business, distinguishing himself by important inventions in that field.

Next the demand for electrical knowledge in the profession of patent attorney, for which Mr. Pope's analytical mind peculiarly fitted him, directed him into that occupation, and he was employed for several years as patent attorney and expert by the Western Union Telegraph Company. From this special work he entered into general practice as patent attorney and expert on his own account. This practice Mr. Pope retained, doing more or less of it as his services were in request, till his death. In 1884 Mr. Pope assumed the editorial management of the *Electrician and Electrical Engineer* (now the weekly *Electrical Engineer*).

Mr. Pope was among the the earliest to recognize promise in THE ENGINEERING MAGAZINE. Almost as soon as the first number appeared, he wrote to the editor a congratulatory letter, stating that he had read it from beginning to end with ever-increasing admiration of its contents, and a conviction that its influence would be wide and important upon the progress of the age. He shortly became, and has since been, one of its most valued contributors, and, later, he also became the electrical editor of the magazine. But his work was not wholly confined to this department. His counsel and influence have more or less pervaded all the departments of editorial work. So much has this been the case that his loss will be felt in this office perhaps as much as in any of the numerous activities which occupied his attention at the time of his demise.

In his practice as an electrical expert and patent attorney—a field of which Mr. Pope was among the first to make a specialty—he acquired the enviable reputation of strict rectitude and reliability. No inducement, financial or other, could induce him to lend himself and his abilities to the support of what he believed to be injustice. An expert witness who would directly or indirectly testify in support of anything he believed to be false was considered by Mr. Pope as a perjurer, in as strict a sense as any common witness who testifies falsely to material facts. Large retainers have been repeatedly refused by him on the ground that he could not conscientiously testify to opinions that he did not fully hold. He was retained in many important patent suits by such litigants as the Bell Telephone Company, Western Union Telegraph Company, Westinghouse Electric Company, etc.

On account of his inflexible honesty he was rarely put on the witness stand, although his testimony, given on any vital point, was always regarded with respect by both sides in a controversy.

Mr. Pope was singularly fond of investigating the history of electrical progress and of electrical inventions and discoveries. Few men of his time knew more of such things than he did, and he might have done the scientific world a lasting service by writing such a history up to date. He had devoted special attention to the work of Henry, Morse, Vail, Thomas Davenport,—the Vermont blacksmith who in an operative model constructed the first electric railway,—and House and Bain, who, after Morse, did pioneer work in telegraphic improvements. He contributed to the electrical press, as opportunity offered, in vigorous, terse, and graceful style, many interesting papers on the work of these men, and upon other topics related to the early history of electrical engineering.

He was also thoroughly informed upon the early history of Massachusetts, particularly of the Berkshire region, where he was long favored with the intimacy of Cyrus W. Field and other members of the distinguished Field family.

The general honor and esteem in which Mr. Pope was held caused him to be named for, and elected to, the presidency of the American Institute of Electrical Engineers in 1886, succeeding in that office Dr. Norvin Green. He was one of the charter members of this society. He was also a member of the British Institution cf Electrical Engineers.

One of his latest works was the superintendence of a change in the electric-lighting plant of Great Barrington, involving the abandonment of steam power and the utilization of water power obtained at a point some 5 miles distant. A full account of this important work was given in an engineering paper presented at the meeting of the American Institute of Electrical Engineers at Niagara Falls, last June.

And now, for our friend, efficient helper, and wise counsellor, who has closed his mortal career, let us say a few words that shall, if possible, impress upon the minds of those who had not the privilege of intimately knowing him something of his personality.

Mr. Pope was of strong, large, physical frame, "square faced and massive," as his portrait indicates. He was a most industrious worker, enduring his work well, because he loved it. His bearing was unassuming, and, though a master in his profession, nothing ever escaped his lips that betrayed egotistic pride, or a contempt for lesser attainments, unless these were made the fit subject for contempt by an offensive assumption of learning. He was kind and obliging in disposition, and ever eager to assist a friend. His large fund of information, his extensive reading, his strong sense, his habit of thinking down to the bottom of subjects, and his varied experience in life rendered him a most interesting companion, and personal intercourse with him was extremely agreeable.

His truthfulness was manifest in all that he did or said. He never, even by implication, made any pretence of knowing anything of which he was not accurately informed ; and, when he made promises, he kept them, even at the expense of needed rest.

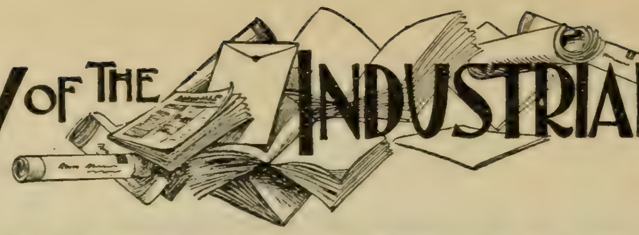
As a writer upon his favorite topics, he stood in the first rank. His acute mind seized readily and easily upon points of weakness in a controversy, and he did not let them escape ; yet his criticisms were mild in form, and not intended to inflict pain. He was one of those rare men who can differ radically in opinion from their opponents, without incurring enmity.

In an interview held on the morning when the New York papers announced the death of Mr. Pope, Mr. T. Commerford Martin, editor of the *Electrical Engineer*, said : "Mr. Pope was one of the few remaining men of the earlier school who, graduating from the telegraph key, had kept in touch with all the later developments of electricity, and had made their mark in each new field as it developed. The art now differentiates so rapidly that the modern electrician tends more and more to become a specialist. In this respect Mr. Pope might well be spoken of as the Nestor of telegraphic electricians."

Mr. Pope leaves a wife, two daughters, and one son. Two brothers are also noted electricians. Mr. Ralph W. Pope is secretary of the American Institute of Electrical Engineers, and another brother, Mr. Henry W. Pope, is an electrician in the service of the American Telephone and Telegraph Company, New York city.

Both the daily and technical press have honored the memory of Mr. Pope by profuse notices, and comments upon his ability and nobility of character ; and we shall ever regard as one of the most pleasant of life's memories his association with the editorship of this magazine.

REVIEW OF THE INDUSTRIAL PRESS



WITH AN INDEX TO THE ENTIRE RANGE OF AMERICAN AND ENGLISH ENGINEERING LITERATURE.

INTRODUCTORY

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance ; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States, Great Britain and the British Colonies; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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Am. Engineer and Railroad Journal. *m*. $3. N.Y.
American Gas Light Journal. *w*. $3. New York.
American Geologist. *m*. $3.50. Minneapolis.
American Journal of Science. *m*. $6. New Haven.
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Am. Soc. of Mechanical Engineers. *m*. New York.
Annals of Am. Academy of Political and Social Science. *b-m*. $6. Philadelphia.
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Architect, The. *w*. 26s. London.
Architectural Record. *q*. $1. New York.
Architectural Review. *s-q*. $5. Boston.
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Electrical Plant. *m.* 6*s.* London.
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Journal Franklin Institute. *m.* $5. Phila.
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Jour. N. E. Waterw. Assoc. *q.* $2. New London.
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Scribner's Magazine. *m.* $3. New York.
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Sibley Journal of Eng. *m.* $2. Ithaca, New York.
Social Economist. *m.* $2. New York.
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Stationary Engineer. *m.* $1. Chicago.
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Street Railway Journal. *m.* $4. New York.
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Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
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Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.

ARCHITECTURE & BUILDING

Austrian Floor Tests.

THE tables herewith presented constitute a valuable addition to architectural and engineering data. They are a part of the report of the arch-tests committee of the Austrian Society of Engineers and Architects, which has appeared in the *Zeitschrift* of the society.*

The report covers: (1) tests of seventeen floor arches with spans of 4 ft. 4.3 in., 8 ft. 10.2 in., and 13 ft. 3.6 in., representing all kinds of floor construction; (2) tests of two culverts of 32.8-ft. span and 1-10 rise; (3) tests of four bridges of 75 ft. span and 1-5 rise; (4) an exhaustive series of tests to determine the strength and elasticity of all materials used in the above arches; (5) a theoretical calculation based on the results attained; (6) conclusion from the result in regard to theory and construction.

In reprinting the report for wide circulation, the object of the society is to bring about desired improvements.

All the tests were made under the strict supervision of the most prominent engineers to insure conformity to usual practice, while the theoretical work was so divided up that each part fell to an expert. A full record of deflection and other details is given. Table I, as herewith presented (span 4 ft. 4.3 in.), includes results for floors in common use. Results for patented floors, also given in the report, are omitted from this review.

Hollow tile arches of the American type are entirely unknown in Central Europe. The floors were intended for a live load of 120 lbs. per sq. ft. The tie-rods were constructed for a test load of 1000 lbs. per sq. ft., at which point they were at a tension of 15,000 lbs. per sq. in. Tests were stopped at 1638 lbs. per sq. ft., because the corresponding safety was more than sufficient and the tie-rods were then strained to their elastic limit, so that a continuation would have resulted rather in a test of the tie-rods than of the floors; up to this load no sign of failure appeared.

TABLE I.—SPAN 4 FT. 4.3 IN.

Brick Arch. Thickness .... 5 91″ Rise .... 5.71″ Dead load. 70 lbs. per sq. ft.				Hollow Brick Arch Thick., 5.91″ Rise... 4.92″ Dead load, 75 lbs. per sq. ft.		Concrete Arch. Th'k., 2.93″ Rise... 4.53″ Dead load, 91 lbs. per sq. ft.	
No.	Load Per sq. ft.	Movt. of Arch.		Movt. of Arch.		Movt. of Arch.	
		Vert.	Lat.	Vert.	Lat.	Vert.	Lat.
1	102	0.02		0.04		0.01	
2	205	0 03		0.08		0.09	
3	307	0.06		0.14		0.15	
4	409	0.09 .		0.20		0.21	
5	512	0.13		0.27		0.25	
6	614	0.17		0.35		0 30	
7	716	0.22		0.39		0 35	
8	819	0.26		0.45		0.40	
9	921	0.31		0.52		0.44	
10	1024	0.37		0 58		0.47	
11	1126	0.41		0 63		0.53	
12	1228	0.46		0.72		0.59	
13	1331	0.50		0 83		0.64	
14	1433	0.55		0.95		0.68	
15	1436			0.95		0.68	
16	1536					0.72	
17	1638	0.22		0.65		0.77	
18						0.76	

Remarks.—The brick arch developed a crushing crack at test No. 7; its joints opened at No. 11; at No. 13 there were two cracks in brick. In test No. 18 the arch remained perfect. The hollow brick arch showed openings in joints in test No. 7, and at No. 12, there was a crack in the brick. In test No. 18 the arch remained perfect. The concrete arch cracked in the cetner at No. 3, and a second crack at No. 7.

The concrete arch (1:5), although but half as thick as the brick arches, showed, on the whole, as good results, and consequently is well fitted to replace them.

The conclusion derived from results indicated in Tables II and III are: (1) brick arches of the thickness given by the size of brick manufactured show the extreme permissible limit of span to be 8 ft. 10.2 in.; (2) concrete arches (1:4) show in both cases adequate dimensions; (3) the Monier arch, with one wire net, has failed to show

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* This report has been reprinted in book form, and may be obtained from Mr. Fr. Von Empenger, consulting engineer, 72 Broadway, New York. Price, postage prepaid, $2.65.

TABLE II.—SPAN 8 FT. 10.2 IN.

		CONCRETE ARCH. Thickness. ... . 3½″ Rise. ... ...9.5″ Dead load.... . ....3140 lbs.		MONIER ARCH. Thick., 1{15/16}″ Rise...10¼″ Dead load.. .. 2460 lbs.		MON. ARCH, concrete floor. Thick., 2⅛″ Rise... 10¼″ Dead load.. .. 5420 lbs		BRICK ARCH. Thick., 5½″ Rise... 9.85″ Dead load .. 2680 lbs.		HOLLOW BRICK ARCH Thick., 3{15/16}″ Rise, . 5⅝″ Dead load.. .. 1191 lbs		CORRUGATED IRON. 3.5″x1.9″x 039″ Rise. ... 9.85. Dead load... .. 143.5 lbs.		CORRUGATED IRON reinforced with angle irons. Th. 2 36″x2.36″ Rise .... 10¼″ Dead load. ... ... 195.5 lbs.	
No.	Load Per sq. ft.	Movt. of Arch.		Movt. of Arch.		Movt. of Arch.		Movt. of Arch.		Movt. of Arch.		Movt. of Arch.		Movt. of Arch.	
		Veit	Lat.	Vert.	Lat.	Vert.	Lat.	Vert.	Lat.	Vert.	Lat.	Vert.	Lat.	Vert.	Lat.
1	102	.04	0.008	.04	.01	.03	.004	.07	.016	.05	.008	.11	.02	.17	.01
2	204	.09	.015	.08	.02	.07	.008	.19	.06	.37	08	24	02	.31	.02
3	307	.17	.04	.16	.04	.13	.02	.33	.10	74	.15	.35	.03	.38	.03
4	409	.24	.07	.24	.06	.19	.03	.51	.16	1.44	.29	.45	.04	.46	.04
5	512	.33	.11	.34	.08	.28	.05	.77	.21			.60	.05	.53	.06
6	614	.42	.16	.43	.11	.37	.07	1.08	25			74	.07	.62	.07
7	716	.53	.20	.55	.13	.43	.10	1.47	.31			.90	.09	.71	.08
8	819	.64	.25	.67	.17	.56	.14	2.07	.39			1 06	.12	.81	.09
9	921	.79	.31	.83	.22	.71	.18							.97	.10
10	1024	.95	.38	1.01	.28	86	.23							1.15	.12
11	1126					1.03	.29								
12	1331					1.21	.35								

Remarks.—At No. 2, for the concrete arch, a horizontal fissure in the unloaded half occurred. In No. 6, for the same arch, a crack at the abutment occurred. This arch totally failed at 1109 lbs. per square foot, one-half of the arch being loaded. At No. 10, for the 1 15-16″ Monier arch, failure occurred with 1217 lbs. per square foot, one-half of the arch being loaded. At No 10 of the 2 1-8″ Monier arch, a longitudinal crack appeared. This arch failed with eccentric load of 1320 lbs. per square foot. At No. 7 of the 5 1-2″ brick arch test a horizontal fissure occurred in the unloaded half; this arch failed under an eccentric load of 885 lbs. per square foot. At No. 2 of the hollow brick arch, a crack in the unloaded half, 9.85″ from the crown, occurred. The arch failed under an eccentric load of 401 lbs. per square foot. The corrugated iron arch failed under an eccentric load of 975 lbs. per square foot, the ends being very much bent and injured. The corrugated iron arch, reinforced with angle irons, failed under an eccentric load of 1099 lbs. per square foot.

TABLE III.—SPAN 13 FT. 3.6 IN.

		MONIER ARCH. Thickness .... 1{15/16}″ Rise .... 15½″ Dead load of arch...... 2215 lbs Dead load of filling.... 4160 lbs		CONCRETE ARCH. Thickness. ...... 3{15/16}″ Rise .. .. 15⅞″ Dead load of arch .... 4420 lbs Dead load of filling.......... 4560 lbs		BRICK ARCH. Thickness........ .. 4⅞″ Rise .... 13.8″ Dead load of arch, not given. Dead load of filling. not given.		MELAN ARCH 13′ 11″ SPAN. Thickness....... ... 3⅛″ Rise . ... 11.4″ Dead load of arch... ... . 4860 lbs. Dead load of filling .... 1549 lbs.	
No	Load Per sq. ft.	Movt. of Arch.		Movt. of Arch.		Movt. of Arch.		Movt. of Arch.	
		Vert.	Lat.	Vert.	Lat.	Vert.	Lat.	Vert.	Lat.
1	102	.02	.01	.01	.0	.15	.05	.05	0.0
2	205	.05	.02	.03	.004	.30	.11	.09	.004
3	307	.10	.04	.07	.02			.14	0.02
4	409	.15	.07	.11	.04			.19	0.04
5	512	.24	.11	.17	.07			.21	0.07
6	614	.33	.16	.21	.14			.25	0.08
7	717	.40	.23	.23	.18			.42	0.12
8	819	.77	.31					.54	0.15
		1.08	.39						
9	1024							.58	0.11
10	1028							.67	0.09
11	1412							.80	0.05
12								0.3	0.02

Remarks.—The 1 15-16″ Monier arch, at No. 4, developed a crack at the abutment, and, at No. 5, a second crack in the unloaded half. At No. 8, the movement indicated took place under 822 lbs. And at No. 9 the arch failed, after 2 1-2 hours, under 895 lbs. per square foot, including dead load. The concrete arch developed a crack at No. 4, through the entire length of the arch, at the abutment. The movement indicated at No. 7 for the concrete arch took place under 662 lbs. This arch failed under 812 lbs. per square foot, including dead the superiority claimed for it, which is the more significant because the Monier arch has been, up to date, the most favored type of fireproof construction in Central Europe.

The report disapproves the use of a concrete floor with the Monier netting, as it needs 1.85 times more concrete and gives only a trifling increase in strength, so that dirt filling, which is more economical, is preferable. Referring to the fact that both concrete arches, with or without wire netting, have shown almost the same behavior, the report further says: "Compared with a plain concrete arch, a concrete arch with one wire netting has shown but little more carrying capacity, so that the difference cannot have any importance to the ordinary building practice." It is also concluded that a little thicker concrete arch may replace it. "To understand this condemnation of the Monier arch, it must be considered that, besides the wire netting, it is composed of a more expensive concrete,—to wit, mortar 1:3. Engineers have for a long time recommended Monier arches with two wire nettings for large spans, as it is evident that wire is needed on both sides of the arch and not in the center, but it is nearly impossible to use two nettings in a small span. This point has been fully justified by the test of the Monier arches with two nettings of a span of 75 ft. and 15 ft. rise, which may be well to insert here, so as not to make a faulty impression. The failure occurred under a one-sided load."

Material.	Thickness.		Breaking load per sq. ft.
	Center.	Haunches.	
Brick	2 ft.	3 ft. 6 in.	590 lbs.
Stone	2 ft.	3 ft. 6 in.	655 lbs.
Concrete	2 ft. 3 in.	2 ft. 3 in.	735 lbs.
Monier, 2 nets	1 ft. 1 in.	2 ft.	1300 lbs.

The Melan arch is a direct outcome of these tests and their results, and was not placed before the committee until more than a year afterwards. It does away with the cross-rods, places the iron at the surface on both sides of the arch, and allows the use of concrete, instead of mortar, as required with the wire netting. Wire netting interferes with the placing and ramming of concrete, as special appliances are needed to hold the netting in place before enclosing it in concrete. The Melan arch was built of 1:5 concrete and three 15-in. I-beams, 39.4 in. apart. The report states: "From the behavior of this construction, there is no doubt that these vaults have a far superior carrying capacity than either the plain concrete or the Monier arch," etc.

Architectural Training.

THE School of Architecture and Applied Arts at Liverpool was inaugurated May 10. An address delivered on that occasion by Mr. T. G. Jackson, A. R. A., and published in the *Journal of the Royal Association of British Architects* (Aug. 22), makes a strong plea for education of architects on broader lines, and points out defects in the present system of office-training, which isolates the architect too much from sister arts.

The school named is intended to give its pupils an elementary practical knowledge of the handicrafts involved in architectural construction, as well as esthetic principles,—of practical construction, as well as the arts of design. In this respect it is an experiment in architectural education the results of which are yet in the future. "Indeed, the whole system of teaching crafts of any kind in technical schools is still in an experimental stage, and we are still in the dark as to what will come of it. In the handicrafts it seems to have sprung into existence to fill the void left by the decay of the old system of apprenticeship. Trades were learned in olden time, and down to our own day, by binding lads to serve under an experienced

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load. The brick arch developed a crack at test No. 2 in the upper surface of 1-4 unloaded arch, at 137 lbs. per square foot and collapsed under 274 lbs. per square foot, including dead load. The Melan arch of 3 1-8″ thickness developed, at test No. 10, a hair crack on the under side of the arch about 11′ 8″ long, visible near the crown; this crack did not widen later, after a pause of 18 hours. The lateral deflections to the right are recorded in the negative.

master, who undertook to impart to them the mystery of his craft. Why this system has fallen suddenly into disuse we must not stay to inquire; enough that it has done so."

The system of apprenticeship is, however, still retained in architecture. "It is still thought a necessary part of the training of an architect for his calling that he should be apprenticed to a practising architect, and learn from him how buildings are designed and carried out. Of course, no one supposes that he can get all his training in that way. He must read for himself, and study for himself as well; he must form his taste by observation of other men's work, both modern and ancient, and he must take every opportunity of being on the works that are going on under his master's direction, so as to see in process of execution the designs which he has known, and perhaps himself worked out on paper. But if he chooses his master wisely, and if the master acts conscientiously by him, that part of his training which will most influence his after-career is that which he gets in his master's office. No training in schools will ever give him the same insight into the proper conduct of an architect's work, nor will any amount of exercises in working samplers, as they may be called, teach him a tithe of what he learns from work to which responsibility is attached,—work that has really to be carried out, work that is intended to endure for generations, and which must therefore be right, sufficient, and practicable, under the penalty of failure and retribution."

For these and other reasons given at length, Mr. Jackson believes the system of apprenticeship in architecture should be retained, and the deficiencies of office-training supplied, not only by reading, private study, and travel, but by technical training in schools like that inaugurated at Liverpool. There is a danger, however, that such schools will come to be relied upon too much, and that their tendency will be to belittle the value of office-training. This can be guarded against by so framing the courses of instruction as not to supersede practice in the office.

Neither the one or the other system of training can "give the student all he wants to qualify him for his career. . . Either will need to be supplemented in a thousand ways, many of which the student must discover for himself, and will go on discovering to the end of his life." Schools like the one under consideration may be great helps, if they do not assume to teach that which can not be taught adequately in schools,—a tendency which should be combatted in all technical schools.

Modern architects work under conditions very different from those of ancient times. "While the modern architect resembles a professional man, and designs his buildings on paper, and directs them from a distance, only visiting them personally for a few hours at a time and at considerable intervals, the ancient architect lived on the building, worked on it with his own hands, and designed it in the actual material, with no drawings to speak of, and with such setting out only as could be done in the mason's shed or on the walls and floors. The modern buildings, in fact, are designed on paper; the old were designed in brick and stone and timber.

"Now, the advantages of the ancient method are obvious. Success in architecture, sculpture, and the applied arts, as they are called, depends on the right treatment of material no less than on brilliancy of design. Material must be used to the greatest economical advantage; it must be used strictly in conformity to its natural properties; the design must express those properties so clearly that it would lose its charm if translated into a different material; no matter how beautiful the design, it becomes bad art, if it is unsuitable to the material employed."

The incongruities and absurdities in the treatment of materials which mar the architecture of so many modern buildings are attributed to the fact that a large proportion of practising architects are "trained on paper only." This fact must be faced and a remedy for it sought, and the establishment of a school of architecture and applied arts is an attempt at finding such a remedy. Whether it alone will prove adequate Mr. Jackson appears to doubt, but he appears to be equally certain that it is an effort in the right direction.

Mathematics and Construction in the Ecole des Beaux-Arts.

IN a paper by James A. White, assistant professor of architecture in the University of Illinois, published in the *Technograph* and reprinted (Sept. 14) in *American Architect*, the course in mathematics and construction in the above-named famous school is described. The information thus given will be interesting to many young men who anticipate a course in this school, or who, at least, would like to take the course if means and opportunity were afforded to them. Only a bare outline will be attempted in this review.

Instruction is given entirely by lectures, 1 hour in length. The examinations are oral, but are supplemented by problems worked "*en loge*," which means that the student is assigned to an alcove and required to work out a problem in a specified time, varying usually from 6 to 12 hours.

All subjects are taught solely from the standpoint of their application to the study and practice of architecture. About thirty-six lectures are given in mathematics, including algebra, trigonometry (comprising the solution of plane triangles, calculations by logarithms, and the relation between a plane in space and its projection), conic sections (mainly confined to a careful study of curves resulting from the intersection of a cone and cylinder by a plane, drawing such curves and their tangents, and measurement of surfaces and volumes), analytical geometry (taught mainly for its application to the curves of flexure of beams), and mechanics (comprising only statics and simple machines).

Both written and oral examinations are required. Professor White says that, "though the French seem to have found the course sufficient to answer the actual needs of an architect, the American practice of adding a little more for the sake of the mental drill is a most excellent one." The course in descriptive geometry is, however, very complete, comprising fifty to sixty lectures, "of which about ten are a review of the part required for entrance and ten on the finding of common shadows." "The best conception of the course is to be obtained from the examination questions, a list of which, divided into six series, is furnished to the students. The oral examination, part of which comes at the middle of the course, is on questions from this list, one being chosen at random from each series. The first series contains about twenty-five questions on the line and plane; the second thirty on the sphere, cone, and cylinder of revolution, problems of angles, the solution of trihedral angles and regular polyhedrons; the third, thirty on cones, cylinders, pyramids, and prisms; the fourth, twenty-two questions on surfaces of revolution; the fifth, twenty-five on ruled and helicoidal surfaces; and the sixth, twenty-five on shadows.

"Twenty-two plates of about forty of these problems must be drawn, and constitute part of the examination. The problems on the first six plates are to be chosen from the first two series, on the second six plates from series three, four, and five, and the remaining ten on shadows.

"One problem must be drawn '*en loge*,' for which 6 hours is allowed. The problem given last year was: 'A cube stands with its diagonal vertical; a second cube of the same size has its diagonal coinciding with the first, but is turned through an angle of 22½°; draw in plan and elevation the intersecting cubes, and find the shadows at 45° on the solid and on the plane of projection.' Pillet's text-book on descriptive geometry is closely followed in the lectures."

The course in stereotomy is also very thorough, "and includes all of Pillet's text except the skew arch." Twenty lectures are given on theoretical construction, and thirty on technical construction, following the text of Brun in outline and "in a condensed form with demonstration of formulas." Seven lectures and 3 days' practical field work are given in surveying.

"The course in perspective consists of twenty lectures, and is very thorough. Three problems are required, besides one *en loge*. The following may be considered as samples.

"'Design a pedestal bearing a statue, the base to be about 1.5 meters across, and either square or circular. Make a drawing of a public place, surrounded by arcades and with a monumental fountain in the center. No side of the square is to be parallel to the picture plane.'

"'Make a drawing from nature of an *ensemble* or architectural detail, the drawing to be at least 0.25 × 0.35 meters.' The problem given last year to be drawn *en loge* was the capital, architrave, and frieze of the Greek Doric Order without triglyphs. The shadows were also required." "The feature of design enters every problem that requires drawing, no matter what the study."

Architecture at the Seaside.

MR. HOWARD CROSBY BUTLER, in *The American Architect* (Sept. 21), discusses American seaside architecture, in which he finds many defects. He holds that the seashore demands a "unique treatment of architecture," supporting the contention by the allegation that "in all periods, throughout all lands, and in all styles, a strict relation has been preserved between architectural forms and topographical characteristics." Now, it is not logical to deny in one form that which one has asserted in another form ; yet this Mr. Butler appears to do almost immediately.

"It would be impossible to find, in the whole world, greater opportunities for the display of taste, more varied natural conditions of scenery and climate, than are afforded by our Atlantic sea-board from the rugged coast-line of Maine, along the bluffs and headlands of Massachusetts and Rhode Island, to the level shining sands of Long Island and New Jersey's sandy beach and smooth green meadows. Yet there is no place where one sees the unwritten law more frequently fractured, no place where incongruity and discord have been more firmly combined to do violence to the sensibilities of the unoffending observer, than at our seashore resorts.

"It is not difficult to find the reason for this. In the search for a suitable style much originality has been shown, and this is highly commendable. Our seashore resorts are new and very different from those of the Old World, and we want a new original style. But, unfortunately, so great is the originality that no considerable number of architects have shown the slightest agreement of ideas on the subject ; the result is, therefore, far from satisfactory."

The author thinks we could benefit by imitating, or at least by the influence of, English and French watering-place architecture, "the coast of England and France being not unlike our seaboard." Along a coast more or less uneven, where sea-frontage is not the main feature, as at Bournemouth or at Etretat, a somewhat irregular style prevails. The houses have more the character of the typical villa than our own have. People who can afford it have sufficient space about their houses to give them a good setting of lawn and trees, and to have the stables inconspicuously situated at a distance from the house. The house itself is large, simple, and picturesque in design. It shows no striving after conspicuousness, but rather after elegance. Even the wealthiest abroad build houses of a modest style, making up for richness and display in simplicity and taste.

Stone and brick are the usual materials for buildings at English and French watering-places. "A marble palace in the style of Michael Angelo is seldom seen by the sea. It would rather offend a Frenchman's taste. Such a building might be suitable beside the blue of the Mediterranean, under the Italian sky, with a background of dark ilex groves and other classic surroundings, but by the gray-green of the Atlantic, beneath a cold northern sky, and with little verdure not parched and brown, the classic porch would seem rather far from home."

Studies in seaside hotel architecture may be found on "the graded and terraced shores at Brighton and Torquay"; and of residences and cottages, not only at these celebrated watering-places, but also at Cabourg and Houlgate, where are both wood and brick examples worthy of consideration. In these examples will be found a marked contrast to what Mr. Butler calls "the overwhelming extravagance of American seaside architecture," in which "every man's house is literally his castle. Huge mansions of baronial style are crowded upon little lots in rows suitable only for modest cottages. It is the pitiable, insane desire in Americans to make a costly display, lavishing expense upon the house and taking little thought about the land; but the display here is simply a foolish waste, for a manor-house without its park loses all its dignity, and castles in rows are absurd. The same extravagance is seen in these very forms of architecture. Towering structures, with steep, broken roofs, all pinnacles and turrets, with oriel-windows and overhanging balconies, are typical of rugged mountain scenery, where peaks pierce the clouds, and crags stand out in bold relief. But beside the sea, where the level line of the horizon is the characteristic feature, a stretch of sand or a line of bluffs and green fields making up the scenery, a long, low structure, sloping roofs, and broad verandas, and, above all, plenty of space, seem much more compatible with the surroundings."

Want of harmony, juxtaposition of incongruous styles and colors, etc., are other criticisms of American seaside architecture, of which the truth is felt when one recalls to mind, and forms a mental picture of, almost any popular American seaside resort.

Concrete Floors.

AN abstract of an article by Mr. George H. Blagrove in the *Contract Journal* (*The Canadian Architect and Builder* for Sept.) represents theoretical and practical views upon a subject of growing importance, as the use of concrete for floors is constantly extending.

The concrete referred to is composed of Portland cement and some sort of aggregate, as sand, gravel, comminuted stone, etc. The author advocates the use of cement of greater fineness than has been commonly used for this purpose, but appears to think it useless to insist on any degree of fineness greater than that which rejects 12 per cent. when sifted through meshes of two thousand five hundred per square inch; at any rate, this is the fineness assumed in his discussion of mixtures, and he further assumes that the cement will "weigh at least 112 lbs. per striked bushel, or about 90 lbs. per cu. ft., and that a briquette of neat cement will have an ultimate tensile resistance of 400 lbs. per square inch after 6 days' immersion in water. To prevent any possibility of using while hot, and so rendering the floors liable to crack after setting, keeping for a month or 6 weeks after mixing, and spreading out and turning over upon a floor during the last 2 or weeks," is a course recommended.

Supposing the ingredients to be thoroughly mixed, we should obtain a concrete upon which some reliance could be placed for its resistance to transverse stress. But thorough mixing embraces the requirement often insisted upon,—that every particle of sand and coarse aggregate shall be completely coated with cement. If there be an absence of cohesion in any part of the mass, all calculations of strength may be at fault.

The question of the nature and proper proportions of the ingredients for making Portland cement concrete is, indeed, a wide one. As bearing upon the construction of floors, valuable information is afforded by the results of Mr. Darnton Hutton's experiments, described in course of the discussion of Mr. John Grant's paper on "Portland Cement" at the Institution of Civil Engineers. Mr. Hutton experimented with bars of concrete 4 ft. long and 1 ft. square, supported upon a 3 ft. span and broken by means of a load hung from the center. The general proportions of cement to other materials was 1 to 9, though sometimes higher. With 1 part of cement, 5 parts of shingle, and 4 of sand, the central breaking weight was 2656 lbs. With 1 part of cement, 5 parts of shingle, and 3 of sand, or a proportion of 1 to 8, the breaking weight was increased to 3023 lbs.,—an increase of about 14 per cent. But, on reverting to the proportion of 1 to 9, with only 9 parts of shingle to 1 of cement, the breaking weight was increased to 9590 lbs.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Architecture and Building in the American, English and British Colonial Technical Journals—See Introductory.

*1300. Contemporary English Architects and Their Work. Ill. H. Heathcote Statham (Showing, by a review of individual careers, that modern English architecture is equal to any, except in the designing of the largest public buildings). Eng Mag–Nov. 3400 w.

1310. Moving a Factory Building. Ill. (Describes the removal of a three-story factory building 350 ft. long and 50 ft. wide to a new site 300 ft. distant, without interrupting work in factory, except on first floor). Lord's Mag–Sept. 700 w.

1372. Dwelling Houses in Munich. Andrew T. Sibbald (Descriptive and interesting. The chief point of distinction between the houses is their age). Arch & Build-Sept. 14. 3300 w.

†1374. Convention Halls. Dankmar Adler (Experience of the author in the construction of such halls). In Arch–Sept. Serial. 1st part. 2200 w.

1376. Mathematics and Construction in "The École des Beaux Arts." James M. White (Published in the Technograph. A description of these branches of work in the school). Am Arch–Sept. 14. 2500 w.

†1472. Some Thoughts on the Training of Architects. An address delivered by Mr. T. G. Jackson, at the inauguration of the School of Architecture and Applied Arts, Liverpool (Architecture defined as good construction inspired from first to last by an artistic motive. The artistic motive is treated as instinctive. The topics of apprenticeship, defects in office training, ancient and modern architects, isolation of the architect from other arts, the study of the history of architecture, and the advantages of a school open to all concerned in building of whatever degree, are discussed felicitously and ably). Jour Roy Inst of Brit Arch–Aug. 22. 9000 w.

*1486. The Empress Theatre. Ill. (Descriptive). Eng, Lond–Sept. 13. 1400 w.

*1535. Some account of Concrete Construction in America (Description of the invention of Ernest L. Ransome, with comments). Builder–Sept. 14. 2800 w.

1560. Architecture at the Seaside. Howard Crosby Bates (Points out the causes of inharmoniousness, and gives useful suggestions). Am Arch–Sept. 21. 1500 w.

*1562. Concrete Floors. George H. Blagrove (The capabilities of the material and the best means of turning those capabilities to advantage). Can Arch & Build–Sept. 1300 w.

*1649. The Walls of Avignon. Ill. (Historical and somewhat descriptive). Arch, Lond–Sept. 20. 2000 w.

1650. Collapse of the Coliseum (Destruction of a mammoth pleasure palace in Chicago, with probable causes). Am Arch–Sept. 28. 600 w.

*1653. The Ireland Disaster (Editorial comments on the subject, proving the inefficacy of law to procure safe buildings). Br Build–Sept. 1200 w.

*1654. The Brick Architecture of Holland. Ill. R. Clipston Sturgis (A brief history of the people who have made so great a mark in the history of nations, with a consideration of their architecture). Br Build–Sept. 2500 w.

*1666. Housing of the Working Classes in Berlin (The condition of this class in respect of their housing appears to be about as bad as possible, calling urgently for improvement). Jour Soc of Arts–Sept. 20. 100 w.

1676. Full Sized Foundation Tests in Calcutta. Ill. Hugh Leonard (Abstract of a paper in Jour. of Roy Inst. of Brit. Arch. These tests were instituted to ascertain what weight could be put on the usual foundation soil without causing perceptible sinking. The soil is soft alluvial. It was found to sustain 1 ton per sq. ft. without any sensibie settling). Eng Rec–Sept. 28. 1100 w.

*1706. What Should Be the Type of a Modern Cathedral? (Editorial consideration of the subject as to plan and style). Builder–Sept. 21. 2500 w.

*1707. The Influence of Poetry on Architectural Development. G. L. Sutcliffe (From an Essay in competition for the medal of the Inst. of Architects, which obtained the second place and a prize. The poet's business not to catalogue the beauties of a building, but to convey the emotions which the building excites). Builder–Sept. 21. 3600 w.

1754.—$1.50. The Philadelphia and Reading Terminal Railroad and and Station in Philadelphia. Joseph M. Wilson, with Discussion (Purpose for which the railroad was constructed, and a detailed, illustrated description of the terminal station with general plans. Interesting engineering and architectural features are comprised in the design. The specifications for different kinds of work are also given). Trans Am Soc of Civ Eng–Aug. 21700 w.

1798. Heavy Framing in Wood and Iron. Ill. F. E. Kidder (In a series of articles under this heading the writer proposes to describe the most approved methods of framing floors, partitions, trusses, etc., where the construction is a combination of wood and iron or steel). Arch & Build–Oct. 5. Serial. 1st part. 1800 w.

1799. Some of Scotland's Ruined Abbeys. Ill. Howard Crosby Butler (Descriptive. The influence of David I. upon Architecture in Scotland). Arch & Build–Oct. 5. 2000 w.

1838. Art in the Modern Church. Barr Ferree (An attempt will be made to examine the present position of church architecture in America from the standpoint of Christian art. The artistic and religious standard of the American church considered extremely low). Am Arch–Oct. 5. Serial. 1st number. 5000 w.

1839. Small Churches in the Isle of Wight. A. B. Bibb (Descriptions of small churches offering many points of interest to students of architecture). Am Arch–Oct. 5. 2000 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

A Ship Canal from Lake Erie to the Hudson.

UNDER the above caption *The New York Times* (Aug. 29) opens the discussion of the most important canal scheme of the day. It begins as follows: "Under the authority of Chapter 79 of the laws of 1895 the people of this State (New York) will vote on the proposition to issue bonds of the State to the amount of $9,000,000, the proceeds to be employed in improving and deepening the Erie, the Oswego, and the Champlain canals. Should the issue of bonds be authorized by a majority vote of the State, the Erie and Oswego canals, under the terms of the act, will be deepened to 9 ft., their present depth being 7, and the Champlain canal will be deepened to the uniform depth of 7 ft. The locks of the canals will also be lengthened, and vertical walls constructed wherever they may be required." The *Times* discusses and strongly criticises the above project as being insufficient for the commercial demands of the country, and advocates a ship canal which shall be 26 ft. deep and 125 ft. wide at the bottom. This would float the largest lake vessels, and such a capacity is necessary, for it is rightfully argued that the present 3000-ton lake steamers will soon give place to those of greater capacity. Small-capacity boats are not economical; the owner of the 250 ton canal boat is lucky if he pays the season's expenses. Such a canal, following the Erie canal and the Mohawk to the Hudson, could be built for less than $200,000,000. "Another proposition that has been considerably discussed is the construction of a canal around the Niagara Falls, giving the lake vessels a deep waterway to Lake Ontario, whence they would reach the Hudson through a canal constructed from Oswego to Syracuse, thence to Utica, and along the Mohawk to Troy." The cost of a canal around Niagara Falls is estimated at $23,000,000, that of one along the Mohawk at $60,000,000, and the work of connecting the Hudson with Lake Ontario would bring the total to $100,000,000. About 30 miles of the Hudson would have to be deepened, bringing the grand total nearly to $150,000,000. Speaking of the increase of traffic that would result, the *Times* says: "Its magnitude may be inferred from the figures showing the tremendous volume of lake commerce. The extent of the lake trade is millions of tons greater than the combined entrances and clearances of all the seaports of the country,—even greater than those of Liverpool and London. The traffic of the Sault Ste. Marie canal is 50 per cent. greater than that of the Suez Canal." Referring to the immense resources of the west, it says: "To connect this affluent region by a deep waterway with the great port of the country, where 70 per cent. of the foreign imports are entered and from which 40 per cent. of the country's exports depart, is a work which even a less aggressive and enterprising people than the Americans would in time attempt, even if the difficulties were vastly greater than those actually existing. . . . . Canada's expenditure for canals which directly threaten our trade has already exceeded $75,000,000. We spent about $7,000,000 in building the Erie canal, and now propose to enlarge it to the next highest stage of inefficiency with the beggarly sum of $9,000,000. The Canadians are by no means visionary in their canal policy. The distance from Duluth to Liverpool by way of Erie canal and New York is 4557 miles; by way of Montreal and the St. Lawrence, 4144 miles; from Duluth to Montreal the distance is 1354 miles; and from Duluth to New York it is 1517 miles." The saving in time will be considerable, as vessels travel in ship canals at a speed twice as great as that of our present canal boats drawn by mules.

This canal would be of importance in another particular. The Canadian canals will open the lakes to foreign invasion in times of war, and, unless the gunboats of the Atlantic could be utilized, great damage would be done and troops landed before defence were possible. "It must not be forgotten that Chicago is building a drainage canal of 21 ft. in depth to the Mississippi. With a ship canal from the Hudson to Lake Erie, it would be possible, therefore, for light-draught gunboats to make the complete internal circuit from New York to New Orleans. . . . There is something to stir the imagination in the grandeur of an undertaking which would extend the facilities of deep-sea transportation 1500 miles inland to the heart of the richest continent in the world. . . . . It is full of the courageous spirit of the modern man." There is everything to be said in favor of the ship canal proposed. It is a question of national importance, in which our government should bear its share of the expense.

The Specific Gravity of Cement.

IN the report of the *Commission des Méthodes d'Essai des Materiaux de Construction* the distinction between weight per barrel and the specific gravity is clearly drawn. A good Portland cement must be well baked to a dense clinker before being ground, in order to insure the chemical union of the mixture into a compound whose composition corresponds to the theoretical formula used. If this is not done, some of the lime may remain uncombined, and thus injure seriously the time-resisting qualities of the cement. Density thus being a desirable feature, the heavier brands sold best until it was ascertained that the finely-ground cement weighed relatively less. *The Engineer* (Sept. 13) thus comments upon the above report: "Consumers were quick to recognize that a finely-ground cement necessarily weighed less—other things being equal—than one which was coarsely ground, and, moreover, that it was not easy to make a satisfactory sliding scale and form a standard of relation between fineness and weight per bushel. At this juncture appreciation of the fact that the specific gravity of a cement is unaffected by the degree of fineness led to the general abandonment of the use of weight per bushel, and to the adoption of the determination of specific gravity in its place. The upshot at the present time is that the specific gravity of a cement is generally conceded to give all the information concerning the quality of a cement which was afforded by the former methods of testing, and, in addition, to give certain other indications of its own. When properly carried out, the experimental error is much smaller, and the results obtained require fewer corrections in order to afford a consistent meaning." Opinions thus decidedly expressed by *The Engineer* certainly carry considerable weight, and suggest at once the performing of parallel trials with such tests as tension, compression, absorption, setting, boiling, etc.,—those generally adopted. It would be a splendid thesis subject. Water cannot be used in these determinations, and various oils are suggested; benzine seems to be preferred.

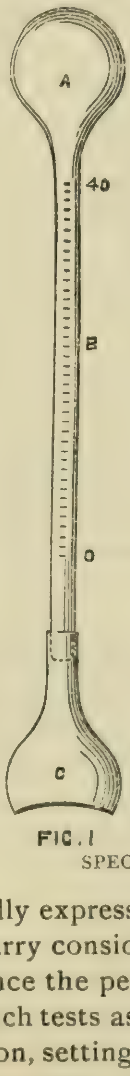


FIG. I

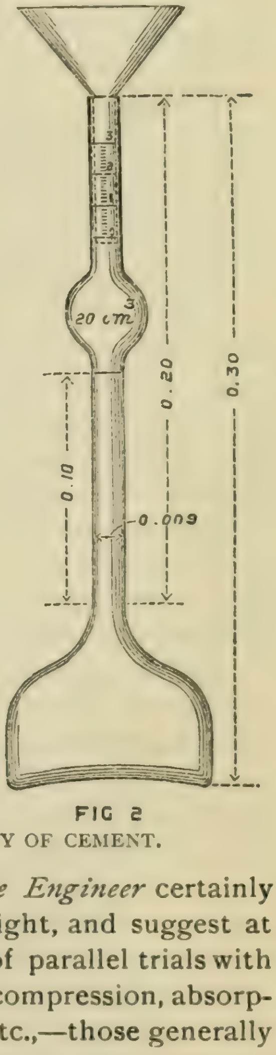


FIG 2

SPECIFIC GRAVITY OF CEMENT.

"Blast furnace slag has a specific gravity of 2.60, and the admixture of any serious proportion with a true Portland cement will be at once indicated by a low specific gravity of the product. . . .

A well-burned cement was found to have a specific gravity of 3.154, and one which was underburned gave the figure 3.108. As gravity can be determined accurately to 0.005, therefore there is no difficulty in telling a well-burned from an imperfectly-burned cement by this method."

The illustrations show two of the best forms of gravity apparatus used; both are made of glass.

The apparatus of M. Caudlot (Fig. 1.) has the bulb A filled with benzine, and is then inverted over the closely-fitting flask C; a reading on the graduated tube is taken, a known weight of cement inserted into C, and the tube again read, the difference in readings representing the volume displaced. The apparatus officially adopted by the commission, however, was that of M. H. Le Chatelier (Fig. 2). This flask has a capacity of 120 cu. cm., with a neck 20 cm. long and a bulb 20 cu. cm. in capacity, the graduations above which for a volume of 3 cu. cm. having a scale with 0.1 cu. cm. divisions, and a diameter of 9 mm. The flask is filled with benzine to the mark below the bulb, and 64 grams of the cement are gradually introduced through the funnel, until the benzine reaches zero on the scale, representing 20 c.c. of cement; its weight is determined by weighing what remains and subtracting from the original quantity of 64 grams. Or the total quantity may be inserted, and the volume read on the scale. Air bubbles seem to be the principal difficulty to be overcome. The method is rapid and easily performed, and could be readily adapted to any laboratory.

Interstitial Space

UNDER the above caption the space between small particles is discussed in relation to the mixing of concrete by Mr. T. Dunkin Paret (referring to an abstract of a paper by M. S. R. Newberry) in the *Journal of The Franklin Institute.* In an abstract of this article *The Engineering Record* (Sept. 14) states that "it is well known that the voids in a mass of particles all of nearly uniform size are greater than when the dimensions of the particles vary largely, and hence in cement testing the voids in standard sand, carefully ground to be as uniform as possible, are much greater than in ordinary gravel." The abstract then states that, "in making a concrete, the materials should be mixed so as to fill the voids as full as possible, the amount of cement required for this being increased by 10 to 15 per cent. for safety." To show that a suitable addition of gravel will strengthen the concrete, the writer gives a table of proportions of cement, gravel, and sand, with the crushing strength of each. Mr. Paret states: "If an absolute rule could be discovered by which proper proportions could in all cases be arrived at, such a rule ought to be of inestimable value, not alone in its relation to the manufacture of concrete, but also to the proportioning of very many mixtures." In some investigations to determine the cause for the variation in quality of emery wheels, a series of experiments was performed which brought out some facts regarding the air spaces between the grains of emery. The following table will show how, as the fineness increases, the weight per cubic inch decreases and the interstitial space increases,—*i. e.*, the finer the material, the greater the volume of air spaces:

Name of Emery.	Number of Emery. Meshes per Inch.	Minims of Water Required to Fill Interstices in 1 Cubic Inch Emery.	Weight of 1 Cubic Inch of Emery in Grains	Per Cent. of Water by Weight Required to Fill Interstices in 1 Cubic Inch Emery.
Tanite Mills Emery	6 U C	131	545	14.05
" " "	10	133	542	14.30
" " "	14	137	539	14.75
" " "	18	139	533	14.99
" " "	24	140	530	15.20
" " "	36	140	526	15.32
" " "	54	141	522	15.51
" " "	80	147	522	16.07
" " "	100	153	512	16.88
" " "	140	160	504	17.80
" " "	180	164	502	18.17
" " "	200	164	502	18.17
" " "	Ex R.F.	180	427	22.27
Average		148	516	16.32
Equal parts by weight of the above 13 sizes		95	675	8.73

These tests were made each in the same manner. It would appear that an analogous process might be used in the investigation of concretes. "While the crushing strength of concrete is no doubt largely affected by the cleanness, roughness, and augularity of the freshly-crushed stone surfaces, and by the areas of the lime and silica which comes in contact, it nevertheless seems evident that the crushing strength would be greatly modified by the amount of filling between the stone being so carefully proportioned to the interstitial space that, when that coarse stone was compressed to its utmost extent, the irregular space would be completely filled, while the faces of the stone which came nearest in contact had only a slight layer or filling between them." As showing the space between large particles, the following table will be interesting:

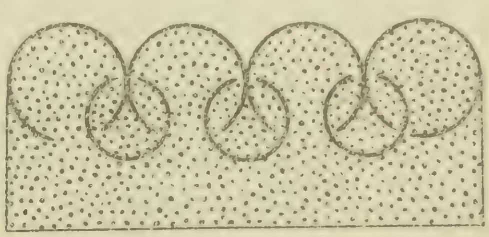
Name of Material.	Approximate Size in Inches.	Weight of 1 Cubic Foot of Material.	Water Required to Fill Interstices Contained in 1 Cubic Ft. of Material, Pds.	Per Cent. of Water by Weight Required to Fill Interstices Contained in 1 Cubic Foot of Material.
Broken ore (emery)	3½×3½×2¼	126	29¼	18.83
" " "	3½×2¼×1¼	116	32¼	21.75
" " "	2 ×1½× ¾	121¼	31	20 36
Rounded stone from creek.......	2¼×1½×2¾	95	27	22.13

"On theory, it might have been imagined that the rounded stone would, as has been suggested for exact spheres, contain more interstitial space than the crushed ore, but the crushed material was so irregular that it formed bridges, and, unlike the fine emery grain, and unlike the stone pounded down in cement and sand, it could not bed itself or become more compact, but remained in the loose position in which it was thrown.

"The facts here given are not presented as affording an adequate explanation of how a perfect cement can be made, but are rather intended to suggest to other investigators practically interested in the subject a method by which exact results can easily and cheaply be secured."

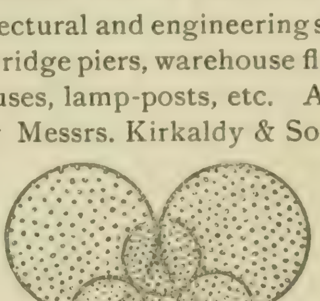
Tubular Structures.

In these days of cheap construction any new device for economy in manufacture or installation is welcome. A novelty comes to us from London through the *Iron and Steel Trades Journal* (Sept. 7), valuable on account of its great degree of adaptability. It consists of a split tube of iron or steel of various thicknesses, engaging at their ends by threads or inter-locking devices. Reference to the accompanying cuts will show the method of fastening together laterally by other split tubes.



"If thick metal be used, it is clear that a very firm grip can be secured, if the width of the slit between the converging edges is rightly proportioned so as to be rather less than the united thickness of the two tubes which it grips. If thin metal be used and stiffness for compressive strength is required, a filling of concrete is inserted which keys the ironwork together. . . . Any number of exterior tubes, from three or more, can be employed in making a column or post, and any thickness of metal, from the thinnest upward."

The material can be used in all varieties of architectural and engineering structures, such as bridge piers, warehouse floors, portable houses, lamp-posts, etc. A series of tests, by Messrs. Kirkaldy & Son, on columns made of tubes of 24 b. w. g. thickness with concrete filling, showed the value of even this thin metal, as "these columns bent to a very marked degree without showing any opening between the various tubular members, showing the strength of this system of jointing. Pieces of wall tested, formed of 2-in. tubes 24 gage, inter-

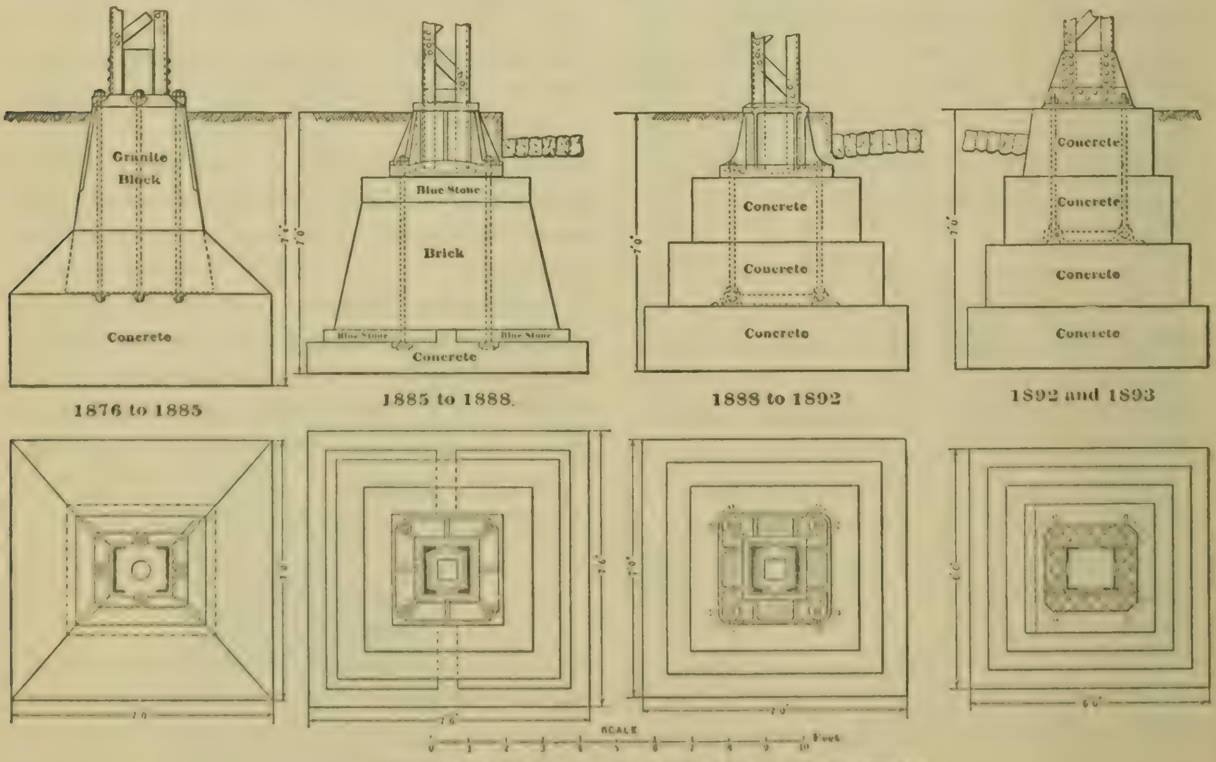


locking so as to form a wall 3 in. thick and 8 ft. high, carried an ultimate load of 17½ tons per running foot."

For walls or partitions these tubes may be left empty or filled. The chief recommendation, however, is low cost. "Owing to the fact that the bending of the material is a rapid and cheap operation, and also the threading together of the same, it is expected that before long columns and posts of this description will be employed for almost every purpose, from the largest bridge pier to the smallest lamp-post."

Elevated Railroad Column Foundations.

THE theme of a paper recently read before the Engineers' Club of St. Louis upon the Brooklyn Elevated Railway, by Mr. A. A. Stuart, was the development toward cheaper and simpler structural design. The author finds this tendency in the elimination of unnecessary braces and stiffeners from the girders and column fasteners, and still more plainly in the construction of column foundations. The cuts of foundations at different dates, here reproduced from *The Engineering Record* (Sept. 14), explain themselves.



1876 to 1885 — 1885 to 1888. — 1888 to 1892 — 1892 and 1893

DEVELOPMENT OF AN ELEVATED RAILWAY STRUCTURE.

"There is nothing unusual or novel in the present type, except perhaps the fact that the concrete is brought to the surface and the columns rest directly upon it, and the subsequent treatment of the exposed surfaces. After the erection of the ironwork, the top surface of each foundation, and its faces for a depth of about 6 in., were roughly pointed off, and then finished with about 1 in. in thickness of a fine concrete, locally called 'Kosmocrete,' composed of the best imported Portland cement and finely-crushed granite,—a composition similar to that used in sidewalks in St. Louis. This work is very much cheaper than the capstones generally used for such purpose, costing but $5 per foundation, by contract, and it was tested before its adoption. Thus far its use has been eminently successful."

The Resistance of Rivets.

IN a special inquiry into the causes for the deterioration of metallic structures, M. Depuy, at the direction of the minister of public works (France), has begun with an investigation on rivets, resulting in the following conclusions.

"(1.) Rivets and bars submitted to tensional stress exceeding the original limit of elasticity; the outside fibres appear to be more strained than those near the center of the rivet. (2.) The rivets do not exactly fill the holes, but they clamp the plates together with a pressure that gives rise to a resistance to sliding equivalent to a weld. (3.) The resistance of the plates to sliding is greater as the limit of elasticity of the material of the rivets is higher. (4.) The limit of resistance to sliding is very variable, the causes being numerous and depending on the nature of the material of the rivets, on the temperature at which the riveting is commenced and finished, and on the method of riveting employed. (5.) The resistances to sliding that may in practice be reckoned on with a joint consisting of not less than three rivets are the following:

Limit of Elasticity of Metal forming the Rivet per Square inch.	Method of Riveting.	Temperature at which the Rivet is Closed.	Resistance per Sq. in. of Sections of Rivet to be Sheared.
Metric tons			Metric tons.
11.4 (iron)	Hand	Bright red heat	2.5
14.0 “	“	“ “ “	3.0
11.4 “	Hydr'lic	White heat	3.2
14.0 “	“	“ “	3.7
14.0 (steel)	Hand	Bright red heat	2.85
14.6 “	“	“ “ “	3.2
14.0 “	Hydr'lic	White heat	3.8
14.6 “	“	“ “	4.2

The hydraulic press used gave a pressure of 38 tons per square inch of rivet section. In all cases the pressure was maintained till the rivet had cooled to blackness. The riveting cups left no mark on the plates. The material was such as to give an extension of 12 per cent. for iron and 18 per cent. for steel before fracture. (6.) When there are several rivets to a joint, they all yield at once. (7.) If yielding has occurred at a joint with deformation of the rivets, the deformation is permanent; but apparently no new effort which does not exceed that which caused the partial failure gives rise to further deformation. (8.) The effort necessary to shear rivets, per square inch of the sections to be sheared, is not less than three-fourths of the tensile strength of the rivet per square inch."

Of the conclusions arrived at which are not usually touched upon, the few rules below will be interesting.

"(1.) The coefficients of safety relating to the rivets depend in no way upon that of the bars. (2.) In bridge work, cross girders should not be over 13 ft. apart to secure safety for the rivets. (3.) Secondary stresses, if not allowed for, may cause the rivets to yield, which will shorten its life, though not necessarily imperil the structure."

These investigations are published in full in the *Annales des Ponts et Chaussées* (Jan.), and should be read by all bridge engineers.

THE Chicago Subway Arcade and Traction Co. is seeking the permission of the city to build 14 miles of subways. "The plan" says *The Engineering News* (Oct. 10), "is to excavate 16 feet below the street surface from house to house, and to cover over this space with an iron and concrete roof, supported on steel columns. All street railway traffic would then be operated in the subway, leaving the street proper for ordinary traffic. Sidewalks and stores will face the subway and all will be well ventilated and brilliantly lighted."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Bridges.

*1301. Will a Bridge Across the Hudson River Pay? Ill. Gustav Lindenthal (An analytical estimate for the first year's revenue of the proposed North river bridge, and of the probable increase of revenue during the first decade,—reached by comparison with the Brooklyn bridge and the New York elevated railroads). Eng Mag–Nov. 3500 w.

1336. The Konigin-Carola Bridge, Dresden. Ill. (A description of a bridge over the Elbe just completed. It is of beautiful design and adds to the attractiveness of this much admired city). Sci Am Sup–Sept. 14. 500 w.

1354. A Diagram for Determining Economical Depth of Girders (Diagram with curves showing the relation between depth of beams, stringers, etc., to the maximum bending moments, with development of formulæ). Eng News–Sept. 12. 500 w.

1360. Transporting a Plate Girder 123-ft.

Long. Ill. (Views and detail drawings). Eng News–Sept. 12. 700 w.

1366. Longitudinal Bracing for Timber Trestles. M. E. Yeatman, in Jour. Asso. of Eng. Soc. (An improvement suggested). R R Gaz–Sept. 13. 800 w.

*1450. The Bellefontaine Bridge (Description in detail of iron bridge over the Missouri, 8½ miles above the Mississippi, with drawings and copies of specifications). Engng–Sept. 6. Serial. 1st part. 1900 w.

1461. True Economy in the Design of Bridges. J. A. L. Waddell (A technical article which is to constitute Chapter III. of a book now in preparation by the author). Eng News–Sept. 19. 2000 w.

*1481. Suspension Bridges of Maximum Span (Editorial abridgment of report of the U. S. Corps of Engineers appointed to investigate this subject). Eng, Lond–Sept. 13. 3000 w.

*1587. On the Resistance of Rivets. — Dupuy (A condensed summary of rules and principles). Ir & St Tr Jour–Sept. 14. 1000 w.

*1614. Solid Floors for Railroad Bridges. Their Merits and the Calculation of Their Stresses (Description of various plans with calculations of strength. Discussion and cuts). Jour Asso Eng Soc–Aug. 5800 w.

1782. Sixteenth Street Lift Bridge, Milwaukee (Description of a double-rolling lift bridge across the Chicago River, 88 ft. long, center to center. Fully illustrated by details and views). R R Gaz-Oct. 4. 1000 w.

1792. A Melan Concrete Arch in Eden Park, Cincinnati, O. Ill. Fr. von Emperger (The arch of this bridge is stiffened and bound by I beams, running along its length, inside the concrete). Eng News–Oct. 3. 1300 w.

*1804. Cylindrical Bridge Piers: New Zealand Midland Railway. Henry William Young and Walter Cleeve Edwards (Description of method of construction with plans and numerous cuts). Ind & Ir–Sept. 27. 3300 w.

†1823. Working Stress in Girder Bridges. F. J. E. S. (Indian Government rules for apportioning sizes of various parts of bridges and girders for dead and live loads. A criticism). Ind Engng–Sept. 7. 2900 w.

1849. The Bellefontaine Bridge. Ill. (Two views with detail drawings of a four span—each 440 ft.—trussed railroad bridge over the Missouri River near Alton). Ry Rev–Oct. 5. 1200 w.

1857. European Prize Designs for Bridges. J. Kübler (Specifications and designs of four European bridges, two over the Danube, one over the Po, and one over the Rhine, with description and drawing of each). Eng Rec–Oct. 5. 3300 w.

1858. Suspension Bridges. Leffert L. Buck (A lecture before the students of the Rensselaer Polytechnic Institute containing much useful information in language easily understood). Eng Rec Oct. 5. Serial. 1st part. 7200 w.

1873—$1.50. Construction of Substructure for Lonesome Valley Viaduct, Knoxville, Cumberland Gap and Louisville Railroad. Gustave R. Luska, with Discussion (Description of a single track steel viaduct of fourteen 30-ft., and five 70-ft. deck spans; length about 800 ft., greatest height 135 ft). Am Soc of Civ Eng–Sept. 4400 w.

Canals, Rivers and Harbors.

*1384. Navigable Waterways in Great Britain and Ireland. Ill. H. B. Thwaite (Their importance and advantages to the agricultural and other interests). Commerce–Sept. 4. 4000 w.

1563. The Montreal, Ottawa and Georgian Bay Canal. Macleod Stewart (A project for connecting Lake Huron with the Lower St. Lawrence River with map of region traversed). Can Eng–Sept. Serial. 1st part. 3500 w.

1565. Concrete Superstructures—Delaware Breakwater. W. G. Warner (Description of methods employed and cuts illustrating construction of masonry and concrete breakwaters, with abstract of practice in other countries). Can Eng–Sept. 2400 w.

1593. The New United States Government Lock at Sault Ste. Marie, Mich. Ill. (Description of an 800x100 ft. ship canal lock, with map, plan, view of excavation and sketches of device for closing leak in cofferdam. An exhaustive article) Eng News–Sept. 26. 3500 w.

1595. The Brooklyn and Port Royal Dry Docks (Editorial criticism of methods and system of Navy Dept). Eng News–Sept. 26. 1000 w.

1620. The Deep Waterways Convention (Programme of meeting, list of papers received and an abstract of a paper by Mr. Clarke, estimating cost and time saved by various routes from Lake Erie to the ocean). R R Gaz-Sept. 27. 1600 w.

1623. Excavator Used on the North Sea Canal Works. Ill. (A chain and bucket excavator having a capacity of about 160 to 200 cubic yards per hour). Sci Am Sup–Sept. 28. 900 w.

1648. To Hoist Vessels from Sea Level to Lake Elevation — Another Deep Waterway Scheme. Ill. (The idea of C. N. Dutton. Extracts from Harper's Weekly. A bold scheme for a 160 ft. pneumatic lift lock brought out at the Cincinnati convention). Ry Age–Sept. 27. 900 w.

1671. The Improvement of the Erie Canal (Editorial advocating both improvement on the Erie Canal and a ship canal). Eng Rec–Sept. 28. 700 w.

*1680. Floods and Weirs (Editorial summary of two papers—one by G. J. Symons and the other by Messrs. R. C. Rapier and G. M. Stoney—presented to section G of the Brit. Asso., and of the discussion which they elicited. Mr. Symons' paper was in the nature of notes upon the Autumn floods of 1894 and the second paper treated of weirs and rivers). Engng–Sept. 20. 4800 w.

1698. The Deep Waterways Convention (Editorial comments with short abstracts from the proceedings). Ry Rev–Sept. 28. 1100 w.

1788. The Effect of the Chicago Drainage Canals on Lake Levels (Report of the Board of Engineers, U. S. A., containing the results of original investigation tending to show that the slight lowering of the lake levels is not liable to interfere materially with lake commerce). Eng News-Oct. 3. 2800 w.

1789. Effect of the Chicago Drainage Canal on Lake Levels. L. E. Cooley (A report submitted to the U. S. Board of Engineers, containing much valuable information, but concluding that the data available was insufficient). Eng News-Oct. 3. 5500 w.

1794. Controlling the Levels of the Great Lakes (An editorial reviewing recent investigations and arriving at the conclusion that no serious results to navigation are liable to follow ; but advocating government action in taking measures to control the water levels of the lakes). Eng News-Oct. 3. 2700 w.

1796. Regulating the Levels of the Great Lakes. G. Y. Wisner (Slightly condensed from a paper read at the convention of the International Deep-Waterways Asso. Effect of withdrawing water from the Great Lakes, on lake harbors, with interesting figures concerning the various lakes). Eng News-Oct. 3. 4000 w.

1797. Effect of Depth upon Artificial Waterways. Thomas C. Clarke (The relation between depth of canals and the character of vessels navigating). Eng News-Oct. 3. 400 w.

*1851. Development of Water Powers. Ill. (A few remarks on water power available, with sketch of dam and sections of three common forms of dam construction). Milling-Sept. 700 w.

Hydraulics.

1351. A New Method for Securing Foundations (Device for sinking foundations in mud by means of a solid bottom caisson pierced by down-flow pipes, carrying water down under pressure, and up-flow pipes carrying away the water with its suspended mud and sand). Eng News-Sept. 12. 400 w.

1353. Water Power Development at the Great Falls of the Potomac (A scheme for damming the Potomac by the Great Falls Power Co., for the purpose of utilizing the over-flow water for developing electricity for the electric light and railways of Washington and Baltimore. Map). Eng News-Sept. 12. 1700 w.

1358. Notes on High Masonry Dams. John D. Van Buren (Abstract of an interesting paper read before the Am. Soc. Civ. Eng., with several superimposed sections of existing dams). Eng News-Sept. 12. 600 w.

1491. The Great Dam of the Peryar, India. Ill. J. S. Chandler (Description of the turning of the Peryar River into the sterile plains of the Madura district). Sci Am Sup-Sept. 21. 900 w.

1544. Moving 36 in. Water Mains Without Shutting Off the Water. E. C. Moore (Abstract of a paper before the Amer. Soc. of Civ. Eng). Ry Rev-Sept. 21. 700 w.

1673. The Otay Dam. Ill. (The insertion of a central water-tight diaphragm in a loose rock dam 160 ft. high). Eng Rec-Sept. 28. 800 w.

Irrigation.

1490. Irrigation in India (Part of a report of the U. S. Geol. Survey, illustrated by map and sketch of bifurcation). Sci Am Sup-Sept. 21. 1900 w.

*1655. Irrigation Works Since the British Occupation of Egypt. Ill. (A complete description of damming one of the branches of the Nile to secure sufficient head for irrigating the delta). Eng, Lond-Sept 20. Serial. 1st part. 6800 w.

†1692. Irrigation ; with an Example of its Application in the Arid Region of Western America. Ill. A. B. Wyckoff (Introduced by general remarks upon irrigation of arid lands. An interesting account is given of irrigation as carried out in Yakima Co., Wash. A comparison is made between the business of a farmer on irrigated land, controlling his own water supply, and the anxieties of agriculturists in humid regions, fearing constantly either drought or superabundant rain). Jour Fr Inst-Oct. 5900 w.

†1728. Future of the Arid West. Edmund G. Ross (A consideration of the advantages of irrigation, and of its hindrances. Opposed to the use of public money for the purpose. Considers how wisely undertaken irrigation can be secured at small cost, &c., &c). N Am Rev-Oct. 5500 w.

Miscellany

*1482. The Specific Gravity of Cement (Facts brought out in one of the recent reports of the French Commission on Structural Materials, with editorial comment). Eng Lond-Sept. 13. 1900 w.

1546. Portland Cement and Concrete. John Watt Sandeman (Extract from a paper read before the Inst. of Civ. Eng. Uniform system of tests of cement and important details regarding the making of cement). Ry Rev-Sept. 21. 3300 w.

1551. The Blackwall Tunnel (Brief account of work on a tunnel under the Thames. Men work under an air pressure of 34 pounds per square inch above atmospheric pressure). Ir Age-Sept. 19. 400 w.

†1739. Portland Cement: Some Points in its Testing, Uses, and Abuses. D. B. Butler (A paper read before the Soc. of Eng. on the properties which render a cement efficient. Tests to determine the same and other considerations of a practical nature). Ind & East Eng-Aug. 24. Serial. 1st part. 2000 w.

1795. The S P R Column Formula (A spirited discussion on a formula for the strength of columns by Messrs. Johnson, Pritchard, Smith and DuBois). Eng News-Oct. 3. 5400 w.

1807. Machinery Foundations. Walter H. Mungall (A comprehensive paper read before the Brit. Soc. of Mining Students, giving facts of interest). Can Min Rev-Sept. 1500 w.

1828. Subjects for Prize Papers, Institution of Civil Engineers, England (Circular issued by the Inst. containing information as to funds available for prizes. A list of subjects for prize papers, and an excerpt from the by laws, relating to disposal of papers, maps, drawings and models presented). Am Gas Lgt Jour-Oct. 7. 2500 w.

DOMESTIC ENGINEERING

Testing House Pipes and Drains.

A GOOD article on this subject, calculated to enlighten owners and occupants as well as plumbers, may be found in *Domestic Engineering* for September. These tests are named the water test, the smoke test, and the peppermint test. Presuming that the pipes are all in place and connected, but yet uncovered, and all openings closed by plugs (there are a variety of plugs for this purpose, generally constructed to become tight by expansion under pressure of a screw), the entire system is then filled with water. If the water at the highest point does not settle away after standing some time, the system is water-tight. Connections should then be completed. If the water settles, there are leaks, which should be carefully sought out and stopped. After the connections of the fixtures are made, the system should be tested again. This may be done by the smoke test, or the peppermint test, or both in succession. The peppermint test is considered by most plumbers the more delicate, but it is more difficult to apply. The smoke test is performed by generating smoke and forcing it into the pipes, while all windows, doors, or other openings which permit free circulation of air into and through the building are closed. If smoke is detected anywhere in the building, there are leaks, which may be discovered by the visible escape of smoke therefrom.

"The peppermint test is applied by taking a small bottle of oil of peppermint and a can of boiling water on the roof and pouring it down the soil pipe, immediately closing the top, and having some one in the house detect if any smell of peppermint becomes apparent, and where it comes from. This test requires delicate handling, and is troublesome. The person on the roof will have to remain some time, for, if he comes into the house, he brings the odor of peppermint with him and spoils the test."

"Maguire tabulates the following list of fifty-one specific insanitary and dangerous defects actually discovered in inspection of dwelling houses. These may prove suggestive to plumbers who are making inspections of systems of plumbing which are suspected of being defective:

"1. Common brick- or stone-built drains under basement.

"2. Large built drains, under or near dwellings.

"3. Pipe drains of larger diameter than actually necessary.

"4. Pipe drains broken, or with leaking points, saturating the subsoil with sewage.

"5. Pipe drains with built or imperfect junctions.

"6. Pipe drains under dwelling without sufficient fall.

"7. Pipe drains with fall in the wrong direction.

"8. Drains of any kind without proper intercepting traps.

"9. Drains of any kind without constant free current of air throughout.

"10. Drains without easy means of inspection.

"11. Drains carried from public sewer direct under hall door steps and under scullery floor, instead of across open area.

"12. Rat burrows from built drains, undermining floors.

"13. Rat burrows from public sewers worked along outside pipe drains into houses.

"14. Defective connection between soil pipes and drains.

"15. Soil pipes inside houses under almost any circumstances.

"16. Soil pipes inside or outside without ample ventilation.

"17. Soil pipes through pantries, larders, or stores.

"18. Defective, badly-placed, or ill-constructed water-closet apparatus and housemaids' slopsinks.

"19. Water-closet cisterns with overflows joined to soil pipes or drains.

"20. Safe trays under water-closets joined to soil pipes or drains.

"21. Two or more water-closets or sinks on one soil pipe, untrapping each other when used.

"22. Overflow pipes connected to soil pipes liable to become untrapped, all very dangerous.

"23. Water supplies over troughs taken from water-closets or other contaminated cisterns, and liable to be used by careless servants to fill bedroom carafes for drinking.

"24. Taps for supplying bedroom water fixed over housemaids' slopsinks, liable to be polluted by splash from slops emptying.

"25. House cisterns, with overflows, joined to soil pipes or drains.

"26. Traps of every kind, without ample ventilation to guard them.

"27. Scullery sinks connected direct to drains, admitting foul air, not only through traps, but through joints of brickwork and plaster all round.

"28. Bell taps, with loose covers on scullery sinks.

"29. Gullies or traps in floors of sculleries, laundries, larders, or basement, etc., connected to drain, and usually dry and untrapped, or full of foul deposit.

"30. Ventilating foul air shafts, discharging near chimneys or windows or ventilating openings.

"31. Rain pipes used as ventilators for drain discharging foul air near bedroom windows or under roof eaves.

"32. Rain pipes used as, or connected to, soil pipes, likely to freeze soil pipe solid in severe winter.

"33. Rain pipes passing down center of houses connected in any way to drains.

"34. Open rain courses from valley gutters, passing under floors to outside down pipes connected to drain.

"35. Rain pipes of low roofs, bow windows, or porches connected direct into drain.

"36. Ashpits located near larder, pantry, or dwelling.

"37. Ashpits liable to let moisture soak into house.

"38. Ashpits capable of retaining moisture, or unventilated.

"39. Rat burrows from defective drains in neighboring premises.

"40. Defective drainage or fittings in neighboring premises.

"41. Any direct communication with drains of neighboring premises.

"42. Water tanks in areas, near ashpits or sculleries, or with any connection of overflow to drain.

"43. Bath waste or overflow pipes connected to soil pipes or drains.

"44. Wash hand basin wastes or overflows connected to soil pipes or drains.

"45. Water-closet cisterns under bedroom or parlor floors.

"46. Cesspools near houses, or unventilated anywhere.

"47. Cesspools or drains near wells.

"48. Drains crossing your house from neighbor's premises.

"49. Field or surface water drains, with open joints under basement connected to house drains direct.

"50. Damp basements or damp walls.

"51. Drinking water defects of source supply or storage."

Unnatural Gardening.

An editorial in *Garden and Forest* (Sept. 11) expresses the view that landscape art reaches its highest development when it deals successfully with the fundamental and permanent features of scenery. Ornate art is permissible in contracted spaces. In such confined surroundings flower-beds laid out by a true artist in a "strictly artificial style" are permissible. But such a style fails painfully in effect, or, rather, produces a painful sense of incongruity in any plan of grounds sufficiently large and important to be designated by the name of "landscape gardening." For example, along the Riverside drive, in New York city, there are "architectural terraces and monumental buildings which need the lines of formal planting to supplement and complete them. Along a stately promenade like the Riverside drive, where the foreground is strictly defined by a parapet, there is an opportunity within this limit for statues, and fountains, and floral embellishments of the most sumptuous and elaborate kind, and this would serve as a fitting framework for the prospect across the broad river with the forest-crowned cliffs and the noble sky-line beyond. Many other places might be named where so-called decorative gardening and geometrical arrangements of flowering plants would be desirable; and, wherever a real artist gives examples of his skill in this direction, he commands the gratitude of every one interested in garden art."

While "formal gardening" is "a legitimate form of art," all formal gardening is not "to be approved." Like style in any kind of art, it has its limitations, and, the grander and more massive the subject, the broader and less formal should be the treatment. "Every one has seen geometrical flower-beds of such elaborate pattern that they never can be properly executed with plants as materials. Even where they are not intrinsically bad—that is, where the figure is pleasing and the colors are not constantly at war with each other—they are often placed where they are out of harmony with the general design and with the special features about them. Wherever in a public garden the recognized canons of art are violated, it is the province of a journal devoted to the subject to criticise such displays, and we have not hesitated to appeal to those in authority, and who are, therefore, in a substantial way, educators of the people, to furnish examples of gardening which will not offend the poorest taste. But there are worse sins than those we have named, and there is no occasion here to characterize such efforts as the portraits of eminent men on the maps of different States wrought out on the turf with houseleeks and echeverias. Such subjects, with the imitations in color of flags and banners, badges and mottoes, are too trivial for serious consideration. They discredit the very name of garden art. Wherever used, they can only disfigure our parks, and are accurately described as horticultural abominations."

Replying to a criticism of *The Independent* that all gardening is artificial, *Garden and Forest* says: "*The Independent* evidently conceives that our sole objection to it is based on the fact that 'these floral pictures are not naturalistic,' and on this assumption it argues that the same objection lies against every cultivated plant and gardening of all kinds. This statement is, in the main, true; but we have often argued that, even in the natural treatment of a landscape, there must be artificial elements which ought to be frankly used. We advocate formal gardening within proper restrictions, for the very reason that it is formal. When we protest against wall-paper designs, it is not because it is unnatural, but because they violate artistic principles in form and color and location. We need not repeat the specific exceptions we have taken against some of the displays in the Boston Public Garden and certain western city parks, but it ought to be stated that there are, in our view, serious objections to these works from economic and other points of view, aside from the fact that many of them are puerile, others are discordant in color or whimsical in form, and nearly all of them are badly placed."

That the "taste of the common people approves" these flower beds is not conclusive in their favor. The taste of the common people cannot be accepted as a criterion in any branch of art. No one would think this argument anything but absurd, if applied to painting, sculpture, architecture, or music. At the same time the taste of the common people should be considered, —rather for its permanent improvement, however, than for its immediate puerile gratification.

"Really, the bulk of our people despise shams and artifice more and more. No one now thinks of sending to a lady a heart constructed of white carnations and pierced with an arrow of crimson ones. Floral designs of fiddles and bells and pieces of furniture have given place to simpler arrangements of more harmonious color. The same change is coming in our pleasure grounds. The picture of four men of life-size rowing in a boat will not again be seen spread out in gaudy colors on the turf of any American park; and it is to be hoped that the famous American eagle with a glass eye, and the Gates Ajar, constructed with bits of blue stone to furnish a detail when flowers of that color were not at hand, have both passed away for ever."

Superabundant Water Supply.

UNDER the title of "The Cart Before the Horse" Dr. Benjamin Lee, secretary of the State board of health of Pennsylvania (*Plumber and Decorator*, Sept. 2), calls attention to a danger arising from superabundant water supply in cases where ample drainage for removing the surplus is not available. He says: "The first thought of a citizen who proposes to build himself a country residence is beauty of location; the second, architectural adornments; the third, possibly, a copious and pure water supply, and with this modern plumbing follows, of course, as a necessary accompaniment. Last of all, he, or his architect, bethinks himself that it will be necessary to find a receptacle for his little stream which he is going to divert from its natural course and fill with the accumulated filth of his household. That which should have been most carefully considered first, before a line was drawn or a plan designed, is left to be provided for last in some haphazard way, as if it were a trifling detail of no moment whatever. The problem may prove impossible of satisfactory solution to himself. Or, if provision can be made in such a way as to relieve himself of annoyance, the chances are ten to one that his neighbor will begin to complain of the flooding of his yard or the pollution of his well; or, what is still worse, and unfortunately of frequent occurrence, sickness may be created in families more remote, the cause of which is unexpected and therefore unremoved.

"As an example out of many which I could cite, the following has recently occurred in my own experience. In one of the most beautiful of the suburbs of Philadelphia resided a gentleman whose business took him to the city every day. The situation of his house was delightful, the drainage of the neighborhood good, the water pure. Every prospect pleased, and only man was vile. Next to his place, and on higher ground, was a comfortable family mansion on a comparatively small plot of ground. The owner of this mansion saw an opportunity for turning it to profitable account by renting it as a summer boarding house. Its situation was attractive, and the old house was soon crowded to overflowing. It was therefore enlarged until it had a capacity for about seventy guests. The old water supply became insufficient, and a new one was introduced, affording a flow of 2000 gallons a day. And now came trouble. There was no proper provision for this flood. Trench drains were dug all over the little lot, but they were insufficient to carry it away. Flowing into the public road in front of our friend's house and even on to his property, it quickly constituted a nuisance of a very serious character. The State board of health was appealed to, and, as the neighborhood, though quite populous, was without incorporated rights or local health authorities, considered it to be its duty to interfere. The effluent was carried under the surface to an old sewer at a distance, and the trouble was temporarily remedied, although by no means satisfactorily and permanently. But now comes a curious part of the story. The engineer inspector did not consider his full duty performed until he had also examined the drainage on the property of the complainant. This gentleman had prided himself on the perfection of his 'sanitary' arrangements, and yet all of his drainage was received into a leaching cesspool. which was close to the house and evidently constituted a serious menace to the health of his own family."

The article concludes with a caution against a too copious water-supply, which may become a means of distributing pollution, and an admonition to architects and owners not to consider the subject of supply before that of drainage, which is what the author calls putting "the cart before the horse."

THE German Hygienic Association offers a prize of $1,200 for a research essay on the efficiency of electric heaters. The programme is as follows: "The heat given out in heating installations by heaters in their various forms and modes of use is to be ascertained. The investigations are to describe in detail the arrangement of the heaters, the nature of the heating agents and the observations made, and to be illustrated by drawings. The heating values are to be stated in units of heat given off per hour per unit of surface. In case of heat given out to air, investigations must be conducted with currents of air at speeds as different as possible. Heaters are to be described in detail, and the relation of heating efficiency to their weight to be ascertained." Essays are to be written in German, and sent with a motto and sealed envelope to Prof. Konrad Hartmann, Charlottenburg, Fasannstrasse, 18, before July 1, 1896.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Heating and Ventilation.

1467. Heating of Forcing-Houses. L. H. Bailey and E. G. Lodeman (From Bulletin 96 of the horticultural division of the Cornell University experiment station, Ithaca, N. Y. An account of experiments in practical heating of forcing-houses). Heating & Ven–Sept. 15. 2000 w.

1468. Boiler Rating. J. G. Dudley (An attempt to classify and bring heating surfaces of different types and sources of heat, each to a common standard, as a basis for estimating evaporative capacity). Heat & Ven–Sept. 15. 1800 w.

1610. Heating and Ventilating in Office Buildings. Ill. (Plans, specifications and full description of heating and ventilating appliances in the 16-story Marquette Building, Chicago). Mas. St Fit–Sept. 700 w.

*1663. The Heating of Buildings—Are the Americans Ahead? (American and English practice compared). Irm–Sept. 21. 1400 w.

1677. The House of Relief. Heating and Ventilation of a New York Hospital. Ill. (Full description with plans). Eng Rec–Sept. 28. 2200 w.

1859. Hot Water Heating and Ventilating in a Large Church. Ill. (This example of hot water heating, described with plans, etc., is notable for the size of the auditorium heated and ventilated, the cubic space therein being 1,060,000 cu. ft.) Eng Rec–Oct. 5. 1200 w.

Landscape Gardening.

1313. Unnatural Gardening (Editorial discussion of the subject, pointing out some of the details that offend pure taste). Gar & For–Sept. 11. 1700 w.

1320. The Palisades Mountain Park. Ill. C. (A general statement of the fundamental conditions of the problem which the Commissioners have to solve.) Forester–Sept. 1. 1800 w.

1555. A Great Battle Park (Editorial on the dedication of the battlefield of Chickamauga). Gar & For–Sept. 18. 1000 w.

1571. Landscape Art in the Military Parks (Editorial in defense of artistic treatment of such parks). Gar & For–Sept. 25. 1200 w.

1734. Suggestion for Autumn Gardens (Editorial calling attention to the harmony that may be produced by attention to color, and selection of plants). Gar & For–Oct. 2. 1200 w.

1735. Late-blooming Hardy Herbaceous Plants. J. Woodward Manning (List of hardy plants for autumn blooming). Gar & For–Oct. 2. 1600 w.

Plumbing and Gas Fitting.

*1431. Testing House Pipes and Drains (An enumeration of fifty-one places wherein danger may lurk). Dom Engng–Sept. 800 w.

*1432. Four Varieties of Lead Pipe Joints. Ill. (A practical discussion). Dom Engng-Sept. 900 w.

*1433. Forty Thousand Dollar Job of Plumbing (Specifications of plumbing fixtures in American Tract Society's Building, New York). Dom Engng–Sept. 1600 w.

1552. Rain Baths. Ill. (Discusses the advantages of the so called "rain bath" and gives a description of a bath room in Utica, N. Y. hospital fitted with douches supplied by the Gegenstrom apparatus, from designs by Paul Gerhard, Sanitary Engineer). San Plumb–Sept. 15. 1700 w.

Miscellany.

*1347. The Cart before the Horse. Benjamin Lee (Discusses the desirability of copious water supply, but points out that in rural districts a want of proper drainage may render a copious supply dangerous to health). Plumb & Dec–Sept. 2. 1300 w.

†1375. Sewage Disposal for Country Houses. Ill. William S. MacHarg (Illustrates the evils of all methods of storage of solids and of constant discharge of liquids upon the surface of the ground; also considers the "Intermittent Sub-Surface Irrigation" system and its advantages). In Arch–Sept. 1400 w.

1556. Protection from Lightning. Ill. (Abstracts from a pamphlet by Alexander McAdie). Arch & Build–Sept. 21. 3700 w.

1630. Incrusted Deposit (Discusses the fouling and cleaning of water-backs in domestic ranges. A good practical article). F. Dye in London *Ironmonger*. Met Work–Sept. 28. 2000 w.

We supply copies of these articles. See introductory.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading and Domestic Engineering.

Better Construction Work Wanted.

MR. KEPPELE HALL (*Electrical World*, Sept. 17) comments upon the alleged fact that experimental work and theoretical discussions are occupying space in electrical journals to an extent that leaves "little time or space to be devoted to the practical side of electrical engineering." It is true, as Mr. Hall alleges, that electrical construction "is not in its infancy." It has grown to adult stature in a marvelously short period, and perhaps this very fact not only accounts for, but justifies, the course of electrical journals in paying greater attention to explorations in new fields than to topics familiar to electrical engineers and constructors. For these journals are published for and circulate among a technical and professional constituency. Except through the medium of reprints and reviews, they scarcely reach lay readers at all. It may be and probably is true, as Mr. Hall declares, that "the average electric installation is inexcusably poor, displaying for the most part poor workmanship, poor arrangement, and poor judgment." But, when he says people do not tolerate poor work of other kinds, such as carpentry, mason-work, and plumbing, we think he is going farther than facts will warrant. Our observation leads to the belief that the average job of carpentry, mason-work, plumbing, or heating work might justly be called inexcusably poor, also. But the average job of electrical construction is not generally found alongside the average job in other departments of building and house-fitting, except in city flats; and, if the average carpentry, masonry, and plumbing in buildings wherein electricity is used for illumination are alone meant, we will not quarrel with the statement. The fact remains that there are many incompetent men who are engaged in electrical construction. As Mr. Hall says, "new electrical light and power companies are being incorporated, more people are availing themselves of the advantages offered, and more men are offered to do the work. A large majority of those who turn to this field are incompetent, and a large proportion of the gullible public are yet to be gulled before they learn by sad experience their error. Now, all this will take time, and in the meanwhile the reputation of the profession must suffer in consequence, unless some urgent measures are taken by those who are really first-class to protect themselves. This requires the coöperation of the public and the good contractors.

"When a man wants work done, and gives it out to contractors to bid on, and receives a number of proposals, all in conformity to the general specifications, but varying widely in price, he almost invariably selects the lowest bidder, especially when he does not know much about it himself, and cannot understand why there should be such a discrepancy in the price when all are going to do about the same work." All this is as true for any other kind of competitive contract work as for electrical work. He who expects uniformly good work done by contract in open competition with other contractors will be surely disappointed. The case is different when only high-class contractors are invited to bid. The competition, thus restricted, may result in good work; but the temptations to overstep a wise limit in competition are great, and even good contractors are often placed, by the acceptance of their bids, in a position where they must either lose money or do inferior work. Experience has proved that human nature is weak in such cases.

The article gives many useful hints and cautions to those that need them. Carpenters make the best wiremen. "They know how a building is put together, they know where they can cut joists and stringers, and—what is just as important, if not more so—they know where they must not cut and notch. They know how to remove and replace lath and plaster, when this is necessary, without tearing down the whole wall of a house, and appreciate the necessity of having good sharp tools to work with.

"Cheap sockets, switches, cut-outs, wire, and other materials may last for a time and give satisfaction temporarily, but eventually they will get out of order and give trouble."

"Concealed work done in anything but conduits" is condemned. "Contractors may insist that wiring in porcelain tubes and cleats, under the floors and behind the plaster, is plenty good enough, and that there will be no danger of anything going wrong. This is not so. The insurance men may permit the practice, but fire is not the only thing to be guarded against. Plumbing or carpenter work will be done some time, and a wire will be broken or grounded, and then comes the search for the trouble, with the consequent tearing up of floors and walls before the trouble can be reached and remedied." A conduit obviates all these contingencies. "Group cut-outs and fuse-blocks separately, as far as is possible in small buildings; and, where this is impracticable, as in a very large building," select distribution centers for each floor, and gather the cut-outs there, each fuse having "a stamped copper terminal showing the carrying capacity," so that, "when a fuse blows, one knows what to replace it with."

"Great care should be taken not to have any one set of lights on one fuse, but all should be arranged so that, when one circuit is disabled, no place will be left in total darkness. Then there are the miserable switches that are so flimsy that they melt up when half loaded, or are so poorly adjusted that they can't be depended upon for half a day at a time. The same may be said of sockets and other materials. This is what makes the cost of house wiring vary so in amount, and it is not simply necessary to look at a man's bid before giving him the work, but to examine his materials and see what he is going to use and how he is going to use them."

"A contractor can generally be sized up from the way in which he performs small jobs. Every man in the construction business is called upon, from time to time, to do small pieces of work, not amounting to much in cost or profit, but work that must be cheerfully done and well done, in the hope of some time securing larger work from the same party. Let us take, for example, ordinary bell wiring for call bells or annunciator. Bell wires should never be run in plaster under one staple. Installations put in in this miserable manner may give satisfaction for a long time, but, when once trouble does occur, it is next to impossible to remedy it. Bell wires, where they run behind plaster, should always be run in tubing, and the man who takes this precaution and uses bells that can be relied on not to get out of adjustment for years, push buttons that will continue to work satisfactorily after long usage, and good reliable batteries, is the man to be trusted with large contracts, with the assurance that the work will be done with the same painstaking care that has characterized his other work."

In conclusion, contractors are advised never "to do inferior work in order to secure a contract. This principle adhered to will eventually lead to success." The author confesses that in all this there is nothing that is new to the profession, but it may serve to guide non-professsional men into wiser courses in contracting for electrical work, and enable them to form a better judgment upon the character of its performance.

Municipal Electricity.

THE above is the title of a paper read by Mr. James Perry before an association of municipal and county engineers at Londonderry, and printed in *The Electrical Engineer* (London, Aug. 23). Mr. Perry is part owner and engineer of the company whose purpose is the public and private supply of electricity in Galway," and he prepared this paper because he "thought that his views and experience . . . . have some interest to his brother municipal engineers." There is a vein of common sense in what Mr. Perry says, but his disparagement of theoretical knowledge does not commend him as an instructor.

Commenting upon this paper editorially, *The Electrical Engineer* admits that "electrical engineers may very comfortably put aside much of the hairsplitting science of the electricians without detriment to the work undertaken"; but it does not back up Mr. Perry's sweeping assertion that "the generation of electricity is purely a question of mechanical engineering." The old debate as to the relative value of theoretical knowledge and practical experience is revived in this discussion. Mr. Perry evidently thinks that a limited knowledge of theoretical principles is sufficient for the needs of the practical electrician, and, as compared with the entire theory accumulated, he is doubtless correct in the view that the principles which must be directly considered in the installation of municipal plants are really few. It would be a pity, however, that practical electricians should be led to undervalue theory. The editorial already quoted significantly says: "It would be a sad day for electrical progress if the pure electrician were to abate one jot of his energy."

Mr. Perry's paper deals mostly with the elementary knowledge needed in the installation and management of municipal plants, and emphasizes its simplicity. A quotation or two will illustrate the general tone of the paper, which, notwithstanding the common sense with which we have credited it (all the more for possessing this merit), will do harm, unless its mischievous tendency is made apparent.

"The engineer has to deal with commonplace electricity; he should in general treat it as Peter Bell did the primrose,—let his cow eat it and turn it into butter. The engineer's electricity is comparable to a leather belt or steel shafting and gearing. It is not a source of power; its humble function in the telephone, telegraph, electric motor, and electric lamp is to transmit power to a distance. Pretentious youngsters and high-falutin newspaper men may talk of the age of steam to be succeeded by the age of electricity; they might as well talk of the coming age of leather belts or of steel shafting. Why should a dairymaid, whose business it is to make good butter, bring to her buttermaking the botany of the plants eaten by the cows, the physiology of the cows, and the chemical composition of the butter? It would be useful for the intelligent dairymaid to know how many ounces of butter she ought to get from a gallon of milk, the temperature at which butter comes, how much water to leave in the butter, and how she can best wash out all the remains of the milk; and she should have proper appliances to enable her to carry out the processes cleanly and properly."

It is all as simple as possible; no need for extended and exact learning. A little primer may contain the whole science of electricity so far as it is necessary for practical purposes. But a glance at only one point of the argument will suffice to show the weakness of the whole. The writer suggests a "3d rate per unit," and adds: "Other people have come to this 3d unit, and the writer is inclined to halve it, as a reasonable rate in large towns. When electricity is to be had at 1½d a unit, a 16-c. p. lamp will keep lighting during 13 hours for 1d."

This remarkable statement is justly criticised in the editorial above referred to, which, as a whole, is a complete refutation of the objectionable parts of Mr. Perry's paper.

"In our opinion, it is altogether bad to make statements of this kind. Ignorant people fasten on them, especially as the ordinary newspaper sub-editor revels in giving them a corner, and thus hundreds, if not thousands, are led to expect something altogether impossible in the majority of cases. We do not say that it is impossible here and there to produce electrical energy so that it may be sold at three-halfpence per unit, but we do say that in the majority of cases at the present time it cannot be done, and there is no likehood of its being done during the lifetime of this generation. It is the average cost and the average selling price that should be the guide, rather than the lowest possible cost and the lowest selling price under the most favorable conditions that can be obtained. It is extremely annoying for a canvasser who calls upon the householder to ask him to introduce the electric light to be met with questions about the exceedingly high price which the company, or the municipality he is canvassing for, charges for the energy supplied. The canvasser is met with the statement that such-and-such an authority says the price to large towns ought to be three-half-pence per unit, and here you are charging fourpence, fivepence, sixpence, or more per unit. These charges may be low when all the conditions are taken into account, but the householder is not the person to trouble himself about the existing conditions. He merely thinks he ought to get it at a certain price, and is annoyed to think that he cannot get it at that price, and refuses to patronize the new light."

It is also alleged in this editorial comment that only a few instances could be found where the actual cost of generating electricity is less than the price suggested by Mr. Perry.

The Braking of Trolley Cars.

AMERICAN MACHINIST recently took occasion to criticise editorially an alleged inefficiency of the brakes on trolley cars, charging broadly that the subject has not received the attention in electrical journals that it merits, and substantially asserting that the alleged inefficiency indidirectly results from the fact that the armature shaft of the trolley motor is geared to the car axle.

"Any mechanic must see at once that the brake, in view of the emergency that it is supposed to provide for, is a slow-acting affair, and, if he will investigate the propelling mechanism of the car, he will easily see that it is, and why it is, purposely made so. The armature of an electric motor, as everybody knows, is quite a heavy part of it, and, running at a high velocity, it is, of course, a powerful fly-wheel; and, when it is noticed that the armature, or the shaft which carries it, is geared to the axle without the possibility of slip, the whole situation is exposed. If the axle is stopped suddenly, something is going to be smashed; so the slow-acting brake is a safety device for the motor."

Electricity (Aug. 14) calls down *American Machinist* for this criticism. It asserts truly that the subject of braking electric cars has not been neglected in the American Institute of Electrical Engineers, or in the electrical journals; it offers to prove this assertion by reference to files of such journals, and the assertion made in the above quotation it avers to be only partly true.

"The mechanical brake is a slowly-acting affair, and purposely so, but not for the reason assigned. The large angular movement of the brake handle is provided simply and solely for the purpose of mechanical advantage, and not for the protection of the gearing, as supposed. To produce the most effective braking, several requirements must be fulfilled. In the first place, the propelling force must be cut off first, and then the retarding effort must be applied. It must be remembered, too, that suddenness of application of the brake is not always or usually a requisite to a good brake."

It is added that, "were suddenness of application the sole desideratum, the electric car would have facilities not found to the same extent in other vehicles, for by simply reversing the motors the wheels would be revolved in the opposite direction. The objection to this method of procedure would not be the one raised by our contemporary,—*viz.*, that it would strip the gears (though there might be some danger of that),—but it would doubtless burn out the armature, and, even if it did not do this, it would fail to bring the car to rest as rapidly as might be done by a proper application of the brake."

The trouble appears to lie between a system which exacts too much of motormen and the motormen themselves, rather than in the brakes *per se*. *Electricity* says: "The chief difficulty with electric cars is their greater weight. No other mechanically-propelled vehicle has as good braking facilities as has the electric car if they are properly manipulated, but the motorman on the usual trolley car has too many things to attend to. He has both hands continually occupied, and, in the case of an emergency, unless he be of better stuff than the ordinary run of men, he will take the necessary steps to check his car in the wrong sequence, or omit one of the steps altogether, both of which are equally bad.

"Electric cars, too, are run at higher speed than other street vehicles, and, although by the present means of braking, a car can be brought to rest from a speed of 10 miles an hour within a distance of 10 ft. if the braking mechanism be guided by proper intelligence, it is exceedingly doubtful if the number of accidents would be much lessened by any improved mechanism which would render stoppage possible within half the distance, unless there were a higher intelligence behind it than that usually found on our street cars."

As to the position taken by *Electricity* that increased safety in trolley railway traffic lies in the direction of improvement in fenders rather than in improved brakes, it seems, from its own showing, that improvement is needed in the system of operating the cars. The motorman performs functions in the order of which he is liable to become confused when these have to be performed in quick succession, and when he is alarmed, as he would be when in danger of running down a pedestrian. His intelligence has little to do with this state of things. Much more intelligent persons than the average motorman would become flustered and commit errors under such circumstances. An emergency drill of motormen is suggested, and might be of service, as firemen's drills have been of service; but, if the trolley lines wish to avoid the necessity of employing men of a higher grade than "the ordinary run of men," some way of avoiding the continuous occupation of both hands by the motormen seems an obvious need in trolley service.

The Tesla Patents.

THE company which controls the patents granted to Mr. Nikola Tesla evidently is planning to make it warm for infringers. In a circular recently sent out to persons and corporations deemed to need the warning, they say: "In view of the great prominence given to the multiphase motors covered by the patents of Mr. Nikola Tesla, we think it right to direct your attention to the fact that this company claims the exclusive right to manufacture and sell all forms of single-phase motors where a second phase is induced so as to make the same a two-phase induction motor, notably the form used for the operation of fans." The advice is also given to those who are using motors of the kind named to avoid permanent injunction by arranging with the company betimes, as a decision in important suits now pending is expected early in 1896, and all indications point to a decision in favor of the owners of the Tesla patents.

Progressive Age (Oct. 11), which gives these facts with editorial comments, while regarding much of the circular as "pure advertising," to be "taken with the large modicum of salt needed by the statement of a corporation with millions at stake and whose fate is still in the hands of the courts, undecided," yet feels it a duty to present the facts on the side of the company.

"It is undoubtedly true that electrical apparatus depending upon alternating currents of two or more phases will play an important part in the electrical industry of the near future. It is still more certain that a decision of the suits in question will throw a tremendous amount of existing apparatus out of legitimate use, and a corresponding amount of new business into the hands of the victor; while rumor has it that all the points of equity, if not of law, are on the side of the aggressive corporation. So that, whichever way the proceeding turns,—and we do not presume to undertake prophecy, or legal analysis of the question,—there will be a large volume of property affected, outside of that owned by the two principal combatants."

The guarantees to purchasers under which a large number of this class of motors have been sold our contemporary regards as worthless, in case the favorable decision expected by the company shall be obtained. "The intentions of the insuring party may have been of the best, but it is now clear that the liabilities which he has thus gradually accumulated are such as will fall, if at all, in a lump, and, when they fall, are certain not only to swamp, but to leave by far the greater portion of the insured without protection or protector. The questions therefore arise: Are these parties, so plainly damaged in equity, to have no recourse in law? And if so, to whom?"

It appears to us that there is no recourse. In such cases one would wish that purchasers could be protected, if possible; but we can see no way whereby a person, having accepted an insufficient security and relied upon it as a sole remedy, can be resecured; and the editorial reviewed admits the extreme difficulty of the case. "Clearly the purchasers should be protected. But by whom? It is plainly not the duty of the successful litigant, who has been merely defending his rights. It is as plainly beyond the powers of the vanquished party. So the question is not a simple one. But it would certainly seem that, if the State cannot guarantee the validity of its patents, before it issues them, or is so slow settling that validity by other means that large numbers of its citizens become involved in losses as a consequence, it cannot be regarded as clear of blame, or at least of indebtedness."

Storage Batteries in Telegraphy.

THE application of the storage battery to telegraphic work, long since an accepted feature of the European practice, is apparently finding much favor of late in this country as well, especially as there are now but few towns of 5000 or more inhabitants in this country which are not provided with a central-station electric plant, from which the cells may be conveniently charged at any time at a trifling expense. In an article in the *Electrical Engineer* (Aug. 14) particulars of some of the most important storage-battery plants of this kind are given, illustrated with diagrams. One of these—that in Washington, D. C.,—has 724 cells; 398 of 50 ampere-hours', 320 of 12.5 ampere-hours', and 6 of 125 ampere-hours' capacity. The main battery of 640 cells is divided into 16 groups of 40 cells each, each of which is tapped so as give 4 different potentials of each polarity, for supplying telegraphic circuits of various lengths and resistances. The 6 large cells furnish 6-volt currents for 80 local sounders connected in multiple. The plant replaces 7300 gravity cells heretofore in use for doing the same work.

Monocyclic Electrical Distribution.

THE so-called "monocyclic" system of distribution,—in which the ordinary type of single-phase alternators may be economically replaced in existing stations by apparatus offering, among other advantages, that of being able to supply power to alternate current motors of a type self-starting under full load,—although much discussed in the technical journals, does not seem to be very well understood by electricians generally. In the *Electrical World* (July 27) a very intelligible explanation is given of the principles of the apparatus, which is accompanied by diagrams, and may be profitably examined.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Electricity in the American, English and British Colonial Technical Journals—See Introductory.

Lighting.

*1302. The Limits of Electric Power Transmission. Alton D. Adams (Showing, by the analytical comparison of costs, how far electric power, hypothetically costing nothing at the point of origin, can be transmitted without entailing an expense exceeding that of generating its equivalent steam power). Eng Mag–Nov. 3200 w.

*1341. Electrical Supply at 230 Volts—The 8-Candle Power Incandescent Lamp—The Electrician's Trouble (Criticism of an editorial in *The Engineer*, suggested by some experience in electric supply gathered at Bradford, Eng., and a denial of the economy of 8-c. p. lamps). Jour Gas Lgt–Sept. 3. 1300 w.

*1385. Aberdeen Electricity Works. Ill. (History and full description). Elec Eng, Lond–Sept. 6. 5300 w.

1389. The Photometry of Arc and Incandescent Lamps. W. M. Stine (An article of interest to all connected with the commercial production of illuminants or the study of their use. The measurement of arc and incandescent lights. In this number the quality and quantity of light and the standard candle power are considered). Elec Ind–Sept. Serial. 1st part. 2000 w.

1391. Electric Street Lighting. George Cutter (Abstract of paper read before the Northwestern Elec. Asso. Important points considered). Elec Ind–Sept. 900 w.

*1392. Electrical Communication between Lightship and Shore. Ill. (Descriptive of two patents having a direct bearing on the question at issue). Elec Rev, Lond–Sept. 6. 3300 w.

*1448. The Electric Lighting of the Entrance to New York Harbor. Ill. (Describes a work tending toward the more complete illumination of the entrance channel of New York harbor, just completed in accordance with the plans of the U. S. Lighthouse Board). Engng–Sept. 6. 1200 w.

*1541. The Blackening of Incandescent Lamps (Discusses Mr. G. Tolomei's experiments claimed to show that the blackening of the globes is due to something else than the deposition of carbon). Ind & Ir–Sept. 13. 800 w.

1566. The Wilkes-Barre, Pa., Electric Light Co.'s New Station. Ill. J. H. Vail (Descriptive). Elec Eng–Sept. 25. 3500 w.

1611. A Cause of Some Electric Troubles. D. Rivers (Discusses causes and remedies for troubles with small, flexible, electrical conductors, such as lamp-cords, &c). Mas St Fit–Sept. 1300 w.

1621. Storage Battery Car Lighting in Germany (Describes a system of lighting by storage batteries carried out on the passenger cars of the Dortmund-Gronau-Enschede railroad in Prussia. The accumulator cells are of the Tudor type). R R Gaz–Sept. 27. 2200 w.

*1656. The Belfast Central Electric Lighting Station. Ill. (Descriptive of one of the largest plants for electric lighting yet installed with motive power generated exclusively by gas-engines, of which there are six of 50 H. P. each, double acting with the Otto cycle). Eng, Lond–Sept. 20. 2500 w.

1710. The Incandescent Gas-Light: Its History, Character, and Operation. Ill. William Gentsch (Bids fair to be an important serial. Its form indicates that it will ultimately be re-printed as a book. It will treat of the following topics: Predecessors of the present incandescent gas-light Mantles. I. Composition. II. Form. Burners. I. Burners for gaseous fuel. Means for increasing the luminosity. II. Burners for liquid fuel. Regulation. Incineration. Protection of mantles (chimneys, etc). Lamps, globes, and lanterns. Operation of the Welsbach light (advantages, disadvantages, applications, etc). The first number deals with the first named of the topics). Pro Age–Oct. 1. Serial. 1st part. 2800 w.

1736. European Incandescent Lamps. D. Paisley (Results of the expiry of the monopoly of the Edison & Swan Co.'s master patents of glow lamps, with tables). Elec–Oct 2. 800 w.

*1810. Regulation of Alternating Dynamos. W. L. R. Emmet (The causes of error considered; a review of some of the peculiarities of machines used). Elec Pow–Oct. 2000 w.

1830. Researches with the Alternating Current Arc (Extract from a paper by Mr. Georges, reporting the results of experiments made by Mr. Oelschlaeger, Dr. Michalke and Mr. Queisser). Am Gas Lgt Jour–Oct. 7. 1400 w.

*1846. The Superiority of Alternating Over Continuous Current for Incandescent Glow Lamps. C. J. Robinson (Experiments made proving claims). Elec Rev, Lond–Sept. 27. 1000 w.

Power.

1314. Electrifying Zion :—The Big Cottonwood Power Transmission, Salt Lake City, Utah. Ill. George Heli Guy (Description of power station, construction, development and costs, with review of natural advantages, commercial possibilities, &c). Elec Eng–Sept. 11. 3500 w.

†1339. Electric Transmission of Power (Describes the system of electric transmission developed by the Siemens family, with illustrations of its applications). Ind & East Eng–Aug. 10. 1700 w.

1365. Electric Traction on Canals (Application of the trolley system to canals). R R Gaz–Sept. 13. 500 w.

1388. Electric Power in the Operation of an Important Cable Road. Ill. (At the 52d and State St. power house of the Chicago City Railway Co. Undertaken in the hope of reducing operating expenses). Elec Ind–Sept. 1200 w.

1443. The Storage Battery Question (Editorial. Argument favoring the ultimate success of storage batteries). Pro Age–Sept. 16. 900 w.

1529.—$1. Compounding Dynamos for Armature Reaction. Ill. Elihu Thomson (A paper calling attention to a type of dynamo in which there is no series winding, though the machine is in effect compounded, or over-compounded at will). Trans Am Inst of Elec Eng–June & July. 2200 w.

1530.—$1. Electric Power in Factories and Mills. F. B. Crocker, V. M. Benedikt and A. F. Ormsbee (Practical tests with favorable conclusions. Discussion). Tr Am Inst of Elec Eng–June & July. 1100 w.

1537. Accumulator Traction. Maurice Barnett (The author predicts a speedy and wide development of the system, and that it will play no insignificant part in the future history of electric traction in this and other countries). W Elec–Sept. 21. 2500 w.

1539. The New Storage Battery Plant of the Boston Edison Company. Ill. W. S. Key (Historical account, and description of battery). Elec Eng–Sept. 18. 1600 w.

1553. Power Consumption by Electric Railways. A. K. Baylor (Read before the Penn. St. Railway Asso. Considered in its relation to the electrical apparatus). Elec Rev–Sept. 18. 2500 w.

1568. Generation and Distribution of Electric Power for Manufacturing Purposes. C. A. Stone and E. S. Webster (Abstract of a paper read before the New England Cotton Mfrs.' Asso. Five cases where electric power can be used to advantage, with consideration of cost). Elec Eng–Sept. 25. 1800 w.

1572. Economical Equipment and Operating of Power-House. H. S. Newton, with Discussion (Read before N. Y. State St. Ry. Asso. Ways and means adopted in the power-house at Syracuse). Elec Ry Gaz-Sept. 21. 3300 w.

1574. Signals on Electric Railways. J. H. Barnard (Read at N. Y. State St. Ry. Con. Signals considered important, with reasons). Elec Ry Gaz-Sept. 21. 1400 w.

*1599. Two of Chicago's Greatest Railway Power Plants. Ill. (Detailed description of the Western Avenue, and California Avenue electric power plants). St Ry Rev-Sept. 15. 2000 w.

*1613. Approximate Analysis of the Use of Coal in an Edison Electric Station of the Type Standard, about 1890. R. S. Hale (A very able paper. Describes the plant in which the analysis was made. the method employed, and illustrates the text with numerous load diagrams). Jour Asso of Eng Soc-Aug. 3300 w.

*1705. The Modern Application of Electricity to Traction Purposes. Philip Dawson (Read before Section G of Brit. Asso. The advantages set forth, different systems considered and favorable conclusions drawn). Elec Rev, Lond-Sept. 20. 5500 w.

†1731. Harnessing the Tides. George E. Walsh (Considering the possibility of utilizing the power of the tides for generating electricity). N Am Rev-Oct. 1300 w.

1861. The Portland, Ore., Light and Power Distribution from the Willamette Falls. Ill. (Description of the turbines, system of distribution, generators, switchboards, line, etc). Elec Eng-Oct. 9. 3300 w.

Telephony and Telegraphy.

1370. Mercadier and Auizan's Combined Urban and Long-distance Telephone. Ill. (Descriptive). W Elec-Sept. 14. 900 w.

1371. Ruling of Patent Commissioner in Important Telephone Controversy (A summary of the points raised in the Scribner-Kellogg controversy over the multiple switchboard patent. An important decision interesting to telephone men). W Elec-Sept. 14. 4500 w.

*1387. Repairing Underground Telegraph Cables in West Africa (An unique engineering experience). Elec, Lond-Sept. 6. 1800 w.

1536. Telephones and Telegraphs at the Chicago Board of Trade. Ill. (Principally descriptive of the telephone installation). W Elec-Sept. 21. 1600 w.

*1701. Some Lessons in Telephony. A. R. Bennett (A general review of the telephone systems in all the European countries, with map, and a tabulated statement of the countries, population, number of exchange telephones, number of persons to each telephone, characteristics of management and order of merit). Ind & Ir-Sept. 20. 3200 w.

1721. "Token" Telephone Service. Ill. (President Morris F. Tyler, of the Southern New England Telephone Co., devises an ingenious pay system which promises to become popular. Descriptive). Elec Rev-Oct. 2. 1000 w.

*1783. Pioneers of Electric Telegraphy. Arthur Shippey (Historical review). Elec, Lond-Sept. 27. 2800 w.

*1845. The Development of the Telephone Service in Agricultural Districts. C. E. Webber (The neglect of rural telephony in England. A consideration of the requirements, costs, advantages, etc.). Elec Rev, Lond-Sept. 27. 3600 w.

Miscellany.

*1303. The Late Franklin Leonard Pope. Editorial (Obituary and biographical). Eng Mag-Nov. 2000 w.

1315. On Magnetic Potential. Frederick Bedell in the Physical Review (Mathematical). Elec Rev-Sept. 11. 1100 w.

1316. A Plea for Better Construction Work. Keppele Hall (Points out defects, and describes requirements for good work. An instructive article to non-expert users of electric lighting plants). Elec Wld-Sept. 14. 2500 w.

1317. An Electrolytic Process for the Manufacture of White Lead. R. P. Williams (Read before the Am. Chem. Soc. Description of process. Arthur B. Brown the inventor of the process). Elec Wld-Sept. 14. 1800 w.

†1322. Marvels of Electricity, in Light, Power, Therapeutics, Physics, and Operations Deemed Impossible by Colleges. Joseph Rodes Buchanan. Arena-Sept. 7800 w.

*1393. On Self-Acting Compensation for Temperature in Standard Cells. Albert Campbell (Three methods of getting rid of the correction for temperature in the Clark cell). Elect'n-Sept. 6. 1400 w.

*1394. The Magnetic Field of a Rectangular Current. G. M. Minchin (A paper giving the expression for magnetic force per unit pole at any point in the plane of a given rectangle when this rectangle is traversed by an electric current). Elect'n-Sept. 6. 800 w.

*1395. The Variation in the Electrical Resistance of Bismuth, When Cooled to the Temperature of Solid Air. James Dewar and J. A. Fleming (Abstract from Phil. Mag. Observations showing that there is a very marked difference in samples of bismuth as regards electrical resistance when subjected to very low temperatures, and that its behavior at these temperatures in magnetic fields is abnormal). Elect'n-Sept. 6. 2700 w.

*1396. A Theory of the Synchronous Motor. W. G. Rhodes (Paper read before the Physical Soc. Mathematical. The author claims originality in his method of attacking the problem). Elect'n-Sept. 6. 2000 w.

*1522. On Some Modern Voltaic Cells of High Electro-motive Force. Desmond G. Fitzgerald (Consideration and test values of various cells, with comments). Elec Rev, Lond-Sept. 13. 2000 w.

*1524. Health Precautions in Accumulator Factories. F. E. Everard (Additional facts and precautions supplementary to the suggestions of Dr. Schoop in issue of Sept. 6th). Elec Rev, Lond-Sept. 13. 500 w.

1525.—$1. Properties of Fuse Metals when Subjected to Short Circuits. Walter E. Harrington (Description of tests from which the author concludes that fuse metals are under no circumstances to be considered in the light or nature of a protection.—Discussion). Trans Am Inst of Elec Eng–June & July. 7000 w.

1526.—$1. Theory of the General Alternating Current Transformer. Charles P. Steinmetz (Description with equations in complex quantities. Discussion). Trans Am Inst of Elec Eng–June & July. 3000 w.

1527.—$1. Location of Grounds in Armatures, Fields, etc. Ill. Clarence E. Gifford (Methods described which the author has found to be rapid, accurate and simple). Trans Am Inst of Elec Eng–June & July. 3000 w.

1531.—$1. Some Features of Alternating Current Systems. Charles Proteus Steinmetz (A review of the work done in the last few years in exploring the actions and reactions of alternating currents). Tr Am Inst Elec Eng–June & July. 5000 w.

1532.—$1. Some Observations on a Direct Connected 300 K. W. Monocyclic Alternator. Dugald C. Jackson and S. B. Fortenbaugh (Description of machine with results of observations. Discussion). Tr Am Inst Elec Eng–June & July. 1700 w.

1533.—$1. Phasing Transformers. Ill. Charles S. Bradley (A description of an arrangement of condensers and cores to produce polyphase and single phase alternating currents). Tr Am Inst Elec Eng–June & July. 3300 w.

1534. Electrical Ottawa. Ill. (A description of some of the electrical features of the capital city). Can Elec News–Sept. 2200 w.

1540. Insulated Wires and Their Peculiarities. A. E. Dobbs (Description of samples collected from various sources. Considers an insulation composed of a light rubber core with two asphaltum soaked braids, or a tape and braid on the outside, would make an ideal insulation for ordinary house wiring). Elec Eng–Sept. 18. 1400 w.

*1557. Molecular Electricity. J. H. Poynting, with Editorial (A careful consideration of the subject starting with the hypothesis that electrical and chemical forces are identical, &c.) Elect'n–Sept. 13. Serial. 1st part. 5400 w.

*1559. The Invention of the Electromagnet. E. Boistel (From *L'Éclairage Electrique*. A reply to M. G. Pellissier). Elect'n–Sept. 13. 2200 w.

1624. Electric Carriage with Fulmen Accumulators. Ill. (Data furnished by Mr. Jeantaud to *Revue Industrielle*, relating to his electric carriage and its performance in the recent Paris-Bordeaux race). Sci Am Sup–Sept. 28. 1400 w.

1628. Electric Welding and Soldering by Dr. Zereuer's Process. Ill. (The fourth and latest process. Three previous ones briefly described and their objections claimed to be overcome by Dr. Zereuer). W Elec–Sept. 28. 1200 w.

1629. Electrical Recording Instruments of the Weather Bureau. Ill. Elisha C. Vose (A brief description of instruments in general use at stations of the first order). Elec Wld–Sept. 28. 1300 w.

*1651. Some Points in the Manufacture of Vulcanized India-Rubber Covered Cables and Wires. Ill. J. Warren (Especially interesting to those engaged in cable making. Care in the manipulation of India-rubber). Elec, Lond–Sept. 20. 700 w.

*1703. Storage Batteries. H. A. Earle (Read in Sec. G. of Brit. Asso. A general outline from a practical point of view. Brief historical review, with interesting features connected with storage batteries). Elec Rev, Lond–Sept. 20. 5000 w.

*1704. Electrification and Diselectrification of Air and Other Gases. Ill. Lord Kelvin, Magnus Maclean and Alexander Galt (Abstract. Communicated to Sec. A of Brit. Asso. Experiments with results). Elec Rev, Lond–Sept. 20. 1800 w.

1709. The Electrical Patent Situation (Editorial on a circular issued by the house which controls Nikola Tesla's patents, to alleged infringers, indicating that decisions of pending suits will be momentous in their effects upon electrical industries). Pro Age–Oct. 900 w.

1749. Action of the Electric Current upon Aluminum Wire. Ill. (The behavior of aluminum wire when raised to white heat and even fused, is very peculiar ; though melted, it does not break, being held in form by a sheath of aluminum oxide which forms upon its surface. From *La Nature*). Sci Am Sup–Oct. 5. 1800 w.

1781. Fires of Electrical Origin. William H. Merrill, Jr (The largest percentage caused by the crossing of telephone, telegraph and similar wires with trolley or electric light wires. The remedy. Other causes considered). W Elec–Oct. 6. 2000 w.

*1809. The Aim of Laboratory Training. W. M. Stine (A discussion with reference to the electrical laboratory training for the electrical engineer). Elec Pow–Oct. 3500 w.

*1812. Electricity in the Astronomical Observatory. Ill. J. T. Monell (Description of the chronograph, driving clock, detector, relay, &c., as used for astronomical purposes). Elec Pow–Oct. 4000 w.

*1813. Modern Uses of the Storage Battery. Max Loewenthal (A few characteristics of the chloride accumulator endeavoring to show its superiority to all existing types of storage batteries. A list of some of the applications in which accumulators are giving satisfactory results. Its use for lighting bicycles, carriages, &c). Elec Pow–Oct. 1800 w.

*1843. On Some New Methods for the Delineation of Alternate Current Wave Forms. Ill. James Mark Barr, W. Beckit Burine, and C. Rodgers (Description of an apparatus that automatically records with great rapidity the wave-form). Elec Eng, Lond–Sept. 27. 1900 w.

*1847. The Magnetic Field of a Rectangular Current. G. M. Minchin (The object of this paper is to show that the graphic rule given in a previous paper by the author, also holds for points infinitely close to the sides of the rectangle. An extension of the result to the case of a rectangular coil will also be made). Elect'n–Sept. 27. 2400 w.

INDUSTRIAL SOCIOLOGY

Successful Co-operation.

In an address before the twentieth convention of the Iron Molders' Union of North America, Mr. Henry Cribben, one of the charter members of that association, very strongly urged the feasibility of coöperative industry, and made a powerful argument in favor of continued effort in this direction. He thinks it is not visionary to look forward to the time when the bulk of the work done in the foundry trades will be done by coöperative associations; and he outlined a scheme whereby, as he thinks, this peaceful revolution could be brought about in 25 or 30 years, believing that under this system all frugal and thrifty members would own their homes and have money in the bank for investment when opportunity offered. His plan, quoted from his address published in *The Foundry* for September, is as follows:

"First incorporate the national association in some State, or secure a charter at Washington and establish permanent headquarters in some city centrally located; resolve to avoid strikes by all possible means . . . . and save money for the purpose of fostering the coöperative movement about to be undertaken. The association to raise, by assessment upon its members, $40,000 or $50,000 annually; one half to be paid during the first 6 months, and the other half to be paid during the last six months of each year. The money to be placed in the hands of five trustees, for the establishment of coöperative machine and stove foundries in the United States, in the following manner: I will take $50,000 annually as the amount of money to be raised by taxation for the illustration. When the first $25,000 is collected, the trustees to offer to invest that amount for the period of 4 or 5 years, or more if necessary, in any city having a union in good standing whose members, individually and collectively, will subscribe an equal amount of money for stock in such foundry. The board of trustees, selected for their honesty, ability, and competency to manage such a business, to constitute a majority of the board of directors in each and every foundry so established. And, taking it for granted that each coöperative foundry so established could be placed on a dividend-paying basis almost within the first 2 or 3 years, it would be no trouble for the union to sell its stock to other parties at a premium above this outlay at the time specified, and use the money for the establishment of additional foundries of the same character in other cities, where the prospects of future successful business would present itself. We would establish in the first 5 years ten foundries, with a paid-up capital of $50,000 each, and, if successful in selling the stock of the union at the expiration of 5 years in each case where the business became profitable,—of which there is no question,—at the expiration of 10 years we would have ten additional foundries established by taxation, and the stock of the first ten foundries established during the past 5 years transplanted, with the premiums earned, elsewhere, making a total at the end of 10 years of thirty foundries; at the end of 15 years we would establish ten more by taxation, and transplant the stock of the twenty foundries established during the first 10 years, making a total at the end of 15 years of sixty foundries; at the expiration of 20 years we would establish ten more by taxation, and transplant the thirty foundries established during the first 15 years, making at the end of 20 years a total of one hundred foundries; at the end of 25 years we would establish ten more foundries by taxation, and transplant the stock of the forty foundries established in the first 20 years, making a total of one hundred and fifty foundries; at the end of 30 years we would establish ten more foundries by taxation, and transplant the stock of the fifty foundries established during the first 25 years, making a grand total of two hundred and ten well-equipped foundries, with a paid-up capital of $10,500,000, to say nothing of the profits accruing therefrom of at least as much as the paid-up capital of the stockholders, or a grand total of capital and profits of $21,000,000, at an expense to the union in 30 years of $1,500,000.

"The above figures show conclusively that the bulk of the stove and machine business of the country would be controlled by the coöperative foundries so established in 30 years, to say nothing of the number of similar foundries that would be established by individual enterprise; and the national association would have a source of revenue that would enable it to do many things it ought to do for its membership . . . . now impracticable for want of money—such as providing for sick and death benefits, life insurance at a very low rate, and the establishment of library and reading rooms in all the leading cities of the country."

The coöperative plan was proposed by Mr. Cribben at a national convention of the Iron Molders' Union 30 years ago, but that body would have none of it, and would not listen to him. Recalling this discouraging reception of his views, and what followed, he said:

"I returned home from that meeting somewhat discouraged, but finally determined, so far as I was personally concerned, that I should at the earliest opportunity become my own employer, if I could find a sufficient number of molders in Rochester to join me, who were of the same opinion, and had money to buy one or more shares of stock; and I began at once to agitate the subject of coöperation, making converts for the new enterprise, determined to convince my associate delegates to that convention that, with $800 of my money and that of my associates, we could become our own employers and enjoy the fruits of our own labor.

"A coöperative grocery store had been in operation in Rochester for something more than a year, which had been improperly managed from the beginning to the finish, and, when we had secured subscribers for about $10,000 worth of coöperative foundry stock, the stock and fixtures of this store were about ready to be sold at auction and the money received from the same applied to pay its debts. Knowing this, I went to a directors' meeting (of the store), and informed them that their auction sale would destroy my coöperative foundry enterprise, and urgently requested them to continue their business for 2 or 3 weeks more, until I could organize and incorporate, and collect my stock subscriptions for, the foundry. They granted the prayer of my petition; we collected $11,500 of foundry stock subscriptions, and the sale of the grocery stock and fixtures took place.

"Before we had organized or secured any subscriptions to the stock, Mr. N. Brayer and myself purchased the foundry property where the office is now located for the sum of $20,000, subject to a mortgage of $10,000 on a contract, and paid $1000. On the ninth day we called for the deed, and the gentleman laughingly remarked it was not ready, seemed to be surprised to find that we had raised the money, and candidly admitted he thought we could not raise it, and that he would pocket our $1000. After making the payment, we had left $1500 to operate the foundry, which for the 5 preceding years had required something like $120,000 per annum to pay the operating expenses. There was no very encouraging outlook for our new enterprise at this time. We had collected all of the available subscribed capital that was possible; but, hearing of a party who was about to engage in the coal business, I went to see him at once, and used my best endeavors to show him the beauties and profits of the stove business, and succeeded in having him loan the company $10,000, secured by second mortgage on the plant and real estate, and we guaranteed him 7 per cent. on his money, whether the company made it or not, and as much more as it would earn in the business. We also paid him $2000 per annum for indorsing our paper discounted at the bank. There were times when the amount of our discounted paper in that bank often exceeded our total paid-up capital seven times. This gentleman remained with us about 3 years, and, when he left us, the company paid him a trifle less than $30,000, his earnings in that time on his original investment being nearly doubled.

"This company has now a paid-up capital of $200,000, and a surplus of nearly $200,000 more, but the property and plant owned by them could not be purchased for the amount of their capital and surplus combined, as it is worth very much more."

Mr. Cribben very pertinently asks: "If such results can be accomplished by five men, with little or no capital, why . . . . could not the coöperative plan as outlined be made a grand success?"

The only answer to such a question is that the general history of such enterprises has shown that, with a few notable exceptions, schemers and manipulators, instead of honest, capable men, get control of the management. If human nature were, on the average, reliable, as in the case of the Rochester experiment, coöperative industry would be a most hopeful remedy for industrial discontent.

Old-Age Houses in Austria.

MISS EDITH SELLERS, in *The Nineteenth Century* for August, writes instructively and entertainingly of the provision made for the support of the superannuated poor in Austria. Contrary to what has been supposed by some, the institution of what are called "old-age homes" dates back to an early period. These "refuges" for "worn-out workers," as Miss Sellers calls them, are, she says, peculiar to Austria. The first was built in the thirteenth century, and was called the Langhaus.

The inmates of this home were once supported and well supported by private charity. The building was destroyed by the Turks in 1529, but another, accommodating from five to six hundred people, was erected, and "during the seventeenth century several similar institutions were founded." How these institutions became changed from mere charities into institutions to which superannuated workers might demand admittance in their own right is stated as follows:

"As time passed, the old-age homes lost, unfortunately, much of their distinctive character, and were often used as hospitals, and even as orphan asylums. The emperor, Josef the Second, however, speedily put an end to this state of things; for, if there was one work of social reform he had more at heart than another, it was that of bettering the condition of the aged poor. He was one of the first formally to enunciate the doctrine that a man who has worked in the days of his strength has the right to be supported by his fellows when old age comes upon him. By the Poor Law which he drew up for his subjects, it is enacted that any person who is destitute may, at the age of sixty, claim from his commune either free board and lodging, or a pension equal in amount to one-third of his previous average annual earnings. And this was to be granted to him, not as a favor, or as charity, but as a right. The Vienna poor-law regulations of to-day, in so far as they relate to the treatment of the aged, are founded on this statute."

As the law now is, "all persons who have a right of settlement in Vienna—*i. e.*, about 36 per cent. of the inhabitants—may, on or after their sixtieth birth-day, claim either a pension, or admission to an old-age home, always providing they cannot support themselves, and have no relatives who are bound legally to support them. As, however, there is room in these institutions for only some 4600 persons, and there are usually more than four times that number who wish to live there,—the pensions are now miserably small,—the Poor Law authorities are vested with a certain discretionary power in deciding who shall, and who shall not, be admitted. And, so far as possible, the preference is given to persons of good character, to those whose destitution is the result of their misfortune, not their heedlessness or extravagance. The great majority of the inmates of these homes, therefore, belong to the respectable poor class. Thus no disgrace is attached to going there: an Austrian would no more think of being ashamed that his father was in an old-age home than an Englishman would be that his had rooms in Hampton Court. One reason why old people in England dread going to the workhouse is the knowledge that, when they have once crossed its threshold, they will be regarded as pariahs even by their nearest relatives."

Some of these homes are directly in the city; others are located a little way out in the country. A description of a typical one follows, which we can only epitomize. The sleeping rooms are large and lofty, each containing twenty comfortable beds. The inmates are permitted to take in personal belongings, and thus they give the rooms a homelike aspect. "In summer the rooms are gay with flowers. . . . . The corridors are furnished with comfortable settees." Daily papers are subscribed for. The men and women sleep in separate rooms, but otherwise are not separated.

The most unique feature is the method of supplying food. Each inmate is furnished with 26 kreutzers daily, and with this sum buys his own food, at a restaurant specially kept for the accommodation of the pensioners. The food, it is stated, is good, yet the restaurant is self-supporting. The food and its cooking are subjected to medical inspection before it can be served, and there is nothing else to distinguish this restaurant from others usually frequented by artisans in Vienna. Inmates are permitted to earn money as they can find opportunity. Each is required to maintain neatness and cleanliness of person and dress. The authorities encourage them in adding to their allowance by earning money, and even give them opportunities for it. If any one is prone to use his money in excessive drinking, or otherwise foolishly, his stipend is cut off, and he is put on rations. Altogether (we have not mentioned the half of the commendable features described by Miss Sellers) these institutions seem to be very much in advance of any others having similar objects of which we have ever heard or read.

Wages in France.

ABSTRACTS of consular reports afford material for a statement of wages paid to workmen in different branches of industry in Paris and the Department of the Seine, in France, which, together with details relating to the condition of the metal industries, are compiled into an interesting statement printed in *The Engineer* (Sept. 6).

In the metal group the industries dealt with are those working metals already extracted from the mineral, and include copper foundries, machine works, rolling mills, tinplate works, wire works, etc. Machinery plays an important part in the working of the common metals, but, owing to the diversity of the products manufactured, the power employed varies widely. Some of the largest and most important works are to be found in these industries, but small shops, and even employees who work at their homes, are abundant. While 100 h. p. per one hundred hands is used in rolling mills, the other industries, except wire works, do not ordinarily use more than 25 h. p. for the same number of hands, and there are many shops where no mechanical power is used. The employees of this group differ widely in respect to the intelligence and skill they are required to exercise. Those working without the aid of machines, such as coppersmiths, fitters, locksmiths, tinsmiths, etc., often possess a high degree of intelligence and skill, their trades requiring them to execute work from designs or by processes the learning of which has required a long apprenticeship and much experience. Those who work with machinery may be divided into those who follow occupations which demand a knowledge of design and a long experience in the trade, together with intelligence and skill in proportion as their machines are complicated, and those who carry on operations which are always of the same character, requiring neither intelligence or skill, who do not make the tools they work with, and consequently are unskilled laborers, called upon merely to acquire a certain degree of dexterity and watch the machines. The latter class have been more or less displaced by women and children, who average 5 per cent. of those employed in iron and steel works and 20 per cent. of those in rolling mills. Except in the manufacture of iron for constructive purposes, the industries of this group rarely work on Sundays. In certain cases where the work on hand is pressing, some workmen may come to the shops for half a day on Sunday, but seldom for the whole day.

The average number of days of production for the whole group is 303. The average number of working days per hand in the iron industries ranges from 1 per cent. to 9 per cent. less than the days of production; the greatest average loss of time in proportion to production in the manufacture of brass and copper for building purposes, and in brass foundries, amounts in the first instance to 15 per cent. The average duration of a day's work varies from 9¾ to 10¾ hours, the average being 10½ hours. In iron works a day varies from 9 to 12 hours, but is rarely the former, being most frequently from 10 to 12 hours. In constructions in iron the day varies according to the season, sometimes being 9 hours and sometimes 11 hours. In rolling mills the hours are 10, 11, and, most frequently, 12, with exceptions of 8 or 9 hours. In iron furniture and wire works the hours are 11, and exceptionally 10. In boiler works the time varies from 10 to 11 hours generally, with exceptions of 9, and sometimes 12 or 13, hours. In iron foundries the hours are 10 or 11. In machine works the day varies from 10 to 11 hours, with rare exceptions of 8 or 12 and more hours. In copper works and foundries the hours are ordinarily 10 and 11, rarely 9 or 12. In the manufacture of faucets and other articles in brass the day is 10 to 11, with exception of 12 hours. Brass and copper works and manufactories of iron for building purposes have their season of greatest production during the summer and autumn months.

Ordinarily, in these industries, the occupations requiring the greatest intelligence and skill are the ones in which wages are highest, but production is an important factor in certain cases, and it sometimes happens that workers turning out certain products in large quantities by mechanical means receive as much as, or even more than mechanics whose occupations require intelligence, knowledge of design, and skill, such as fitters, for example, who cannot work by the piece.

It is impracticable to give here the entire schedule of wages for all occupations; a general inference of the relation that wages in France bear to those in other lands may be formed from wages paid to blacksmiths and machinists, a schedule of which follows:

Occupations.	Time or piece work.	Average wages per day 10 hours.			
IRON INDUSTRIES.		s.	d.	s.	d.
Blacksmithing, rolling mills, bolt, axle, and spring making—					
Boltmakers	Piece	3	2⅜—	4	4⅞
Blacksmiths	Time	4	4⅞—	5	0
"	Piece	3	7¼—	17	7¼
Boys	Time	0	10½—	3	0
Catchers	Piece	5	7¼—	6	4⅞
Clippers	Piece	2	9⅝—	4	0
Roll turners	Time	12	9⅝		
Fagot hands	Piece	4	0 —	5	0
Feeders	Time	4	4⅞—	5	0
Filers	Piece	4	9⅝—	6	4⅞
Firemen	Piece	4	0 —	4	9⅝
Fitters	Time and piece	4	0 —	9	7¼
" helpers	Piece	3	2⅜—	4	0
Foremen	Time	7	7¼—	16	0
Forge hands	Piece	3	2⅜—	4	4⅞
Furnace hands	Time and piece	3	2⅜—	13	2⅜
" helpers	Time and piece	4	0 —	11	2⅜
Hammerers	Time	14	6¾		
Machinists	Time and piece	6	0 —	18	9¼
Moulders	Piece	5	7¼—	8	9⅝
Mounters	Piece	4	9⅝—	6	4⅞
Polishers	Piece	5	3¼		
Punchers	Piece	1	2⅜—	2	0
Reducing rollers, before	Piece	6	4⅞—	7	⅜1
" " behind	Piece	5	9¼—	6	4⅞
Rollers	Piece	5	7¼—	10	4⅞
"	Time	5	2⅜—	10	0
Rounders	Time	4	0		
Sawyers	Time	4	7⅝—	6	2⅜
Spring makers	Time	5	2⅜		
Strikers	Time	2	4⅞—	5	2⅜
"	Piece	2	4⅞—	5	4⅞
Temperers	Piece	6	0		
Thread cutters	Piece	2	9⅝—	4	0
Machinery construction—					
Counter sinkers	Time	6	0 —	9	7¼
Fitters	Time and piece	1	2⅜—	9	7¼
Foremen	Time	6	4¾—	19	2½
Machinist electricians	Time	4	9⅝—	6	0
Machinists	Time	2	0 —	8	0
"	Piece	2	4¾—	9	7¼
Modellers	Time	4	0 —	7	2⅜
Moulders	Time	5	8		
Planishers	Time and piece	6	0 —	9	7¼
Rivetters	Time	5	11		
Setters-up	Time and piece	4	4¾—	8	0
Smiths	Time	4	9⅝—	10	4¾
"	Piece	5	2⅜—	10	4¾
Turners	Time	3	4¾—	7	7¼
"	Piece	4	0 —	9	7¼

Inheritance of Property a Social Evil.

THE opinion that the inheritance of property is wrong in principle, and that the power to bequeath wealth ought to be either restricted or abolished altogether, is not new. It has been frequently discussed. The right of the living to control the disposal of wealth before death is the main theoretical obstacle in the way of abolishing testamentary disposal of property, and it appears to us that the latter could not effectually be prevented without at the same time abolishing the former. For, if a man can actually divide up his estate among those whom he wishes to benefit before he dies, it would, while affecting himself somewhat differently, have the same effect upon the tenure of the heirs and upon the distribution of the property after his death. The social effects of such disposal of estates would be in no wise different from their disposal by will, except, perhaps, that lawyers might find less to do. Doubtless, however, there would be an increase of litigation over the disposal of property before death.

No less conspicuous a writer than Nordau has, however, championed "the abolition of the artificially-created right of inheritance." The words are quoted from *The Journal of Gas Lighting*, a journal that has of late dealt much and ably with social questions, and which reviews, in the issue named, Nordau's latest work, "Conventional Lies of Civilization." Nordau says:

"The causes of modern revolutions are not constitutions on paper and democratic party cries, but the longings experienced by so many to toil less and live better." It is not, says the *Journal of Gas Lighting*, as Nordau is careful to show, "that the majority of the people now living under civilized conditions are absolutely poor. On the contrary, as compared with their forefathers, they are much more comfortably circumstanced. The trouble arises from the undoubted fact that they are relatively poorer, in comparison with the rich of their own epoch, than the tillers of the soil, the hewers of wood and drawers of water, who were their predecessors. This Nordau puts to the discredit of the modern growth of the city and the factory." Nordau says that "this is the point to which all the countries of Western Europe have arrived,—countries considered to be the wealthiest and most highly civilized in the world. Their population is divided into a small minority living in the midst of an aggressive and extreme luxury, and a vast number consisting of persons who can support life by the hardest exertions, or who, in spite of all their efforts, find it impossible to attain to a normal human existence. . . . Never before were there so many persons entirely without possessions as at the present time." The "appropriation of the results of others' labor, not one's own," is the cause, in Nordau's opinion, of all this "inequality of distribution." "When the real estate inherited by a certain man increases in value, it is not the result of his own exertions, but of the fact that the number of workingmen torn from the land and soil is constantly increasing, that all forms of industry are growing in extent, that the cities are becoming more and more populous, that the labor of civilized society is being confined more and more to manufacturing industries, thus causing the price of provisions to rise in the same proportion as the price of manufactured articles is falling,—in short, because other men are working, not because the landed proprietor exerts himself. When the speculator amasses millions, it is by the abuse of a superior strength, either of information, sagacity, or of combination, with which he deprives the laboring and saving classes of their property, just as the brigand relieves the wayfarer of his purse, first knocking him down with his club. When the manufacturer becomes a Crœsus, it is by systematic plundering of his workmen, who receive, for their exertions in his behalf, nothing more than food and shelter, like so many domestic animals, and both the scantiest possible. The entire results of their labors flow into the money-bags of their master."

"When a man accumulates a fortune, he wishes to bequeath it to his family in such a way that its members will be, if possible, relieved forever from the necessity of earning their own livelihood. This is contrary to nature's laws. It is a violent disturbance of the regular arrangement of the world, according to which every living being is compelled to win for himself his place at the great table of nature, or perish. This disturbance of nature's regulations is the cause of all the evils of the economic world."

Yet we shall find, if we examine into the subject, that a very large number of the wealthiest people did not gain their estates by inheritance, and large estates are constantly dissipated by those who inherit them. The capacity to amass implies the power to keep, after gaining, wealth. Those who inherit property rarely inherit the ability to amass or to keep wealth, and these talents, even if inherited, not being cultivated, after a generation or two cease to be transmitted. When a social economist finds in any one thing the sole cause of all existing social evils, it seems that his mental vision must be narrow.

THE Bankers' Magazine for October says the Bank of New Zealand is again in need of assistance. In ordinary times this would have attracted considerable attention, and perhaps caused weakness in the colonial market. Nowadays no one thinks of anything but "Kaffirs," and colonial stocks were entirely unaffected. The telegrams on the subject are rather vague, and it is impossible to deal fully with the matter until adequate details have been received by mail; but it appears that the parliamentary committee appointed to inquire into the company's position found that the banking deficiency amounted to £377,000, the contingent deficiency to £200,000, and the Estates Company's deficiency to £1,340,000.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Industrial Sociology in the American, English and British Colonial Technical Journals—See Introductory.

*1304. The Currency Problem and Its Solution. Abraham Mills (Showing that the United States government ought to borrow gold in London, redeem therewith the greenbacks, and retire from the banking business). Eng Mag–Nov. 3200 w.

*1305. Taxation in the United States. Edward Atkinson (An analysis showing the burden of taxation per capita in the United States, with a view to stimulating economists to a study of the comparative taxation of different countries). Eng Mag–Nov. 4000 w.

†1321. A Visit to Broken Hill. Moreton Frewen (The industrial value. Industries dependent on this camp, &c). Contemporary Rev–Sept. 1800 w.

†1323. The Labor Exchange. F. W. Cotton (The central provision of the Labor Exchange is the certificate of deposit which enables people to conduct business without resort to legal-tender money. Its advantages). Arena–Sept. 750 w.

1349. Agriculture and Shipping—A Movement to Secure for them Equitable Protection (Gives a history of the so-called "Lubin" proposition to have the government pay a bounty on agricultural exports and of the adoption of this proposition as a plank in 1894 by the Republican party in California; and also of the initiation of a co-operative movement between the shipping interests and the agricultural interests, whereby each is now endeavoring to obtain the adoption of a national bounty system both working in harmony for these ends. The aims sought, the means adopted to further the project, and its present status). Sea–Sept. 12. 10800 w.

*1381. A Party with a Future. J. Louis Garvin (The Independent Labor Party in England, otherwise called "Laborists." This prediction is based on the results of the last general election. The further prediction is made—with reasons assigned—that the socialistic movement will be a power in the general election of 1900). Fortnightly Rev–Sept. 6000 w.

†1382. The Climax of Agricultural Disaster. William E. Bear (Calling attention to the peculiar bad luck of the agricultural classes in England, in the shape of the bitter disappointment which they have suffered time after time when they had apparently had reason to hope for some improvement in their condition). Fortnightly Rev–Sept. 4200 w.

†1383. The Awakening of China. M. Rees Davies (A review of China's attitude in the past, its present position and outlook for the future. The commercial aspect). Fortnightly Rev–Sept. 5400 w.

†1397. The Present Condition of Russia. Prince Kropotkin (The need of thorough reconstruction. The problems to be met). Nineteenth Cent–Sept. 8000 w.

*1421. Continental versus English Workmen (Editorial. An interesting contrast). Ir & Coal Tr Rev–Sept. 6. 2000 w.

*1429. Abstracts of Consular and Diplomatic Reports (France: Wages in Paris and Department of Seine). Eng, Lond–Sept. 6. 1300 w.

*1434. Address of R. T. Crane to His Workmen (A comparison between manufacturing industries forty years ago and those of today. Relations of the employers to the employed). Dom Engng–Sept. 5000 w.

*1466. Mr. George Livesey Interviewed (An interesting account of profit sharing, given by the chairman of the South Metropolitan Gas Company, in which this system and other reforms have been satisfactorily introduced). Gas Wld–Sept. 14. 1600 w.

1475. Co-Operation. Henry Cribben (An exceedingly interesting and instructive paper read before the 20th convention of the Iron Molder's Union of North America. Gives a history of the organization, progress, and present condition of the Rochester Co-operative Foundry. A remarkably successful social experiment). Foundry–Sept. 6000 w.

We supply copies of these articles. See introductory.

*1510. The Trades Union Congress (Editorial review of proceedings of the 28th congress of what is called the "Labor Parliament," with general remarks upon these congresses. Disapproves certain socialistic resolutions, although admitting that the general character of the proceedings commands respect). Engng–Sept. 13. 2100 w.

*1582. Commercial Relations between Germany and the United States (The appointment of a commercial agent, who has been attached to the German Consulate-General at Chicago. The appointment made in order to afford facilities to business houses and manufacturers in Germany to form connections and to extend their business in the United States). Board of Tr Jour–Sept. 2000 w.

*1583. The Economic Condition of Uruguay (Based on a report of Her Majesty's Consul at Montivideo. Official statistics are always twelve months in arrear. The figures given for 1894 are not official but may be relied upon as correct). Bd of Tr Jour–Sept. 1600 w.

*1584. New Trade Market in China (Interesting account of a new trade market which has recently been opened in China, at Yatung, in Thibet). Bd of Tr Jour–Sept. 2500 w.

*1585. Tariff Changes and Customs Regulations (Russia, Sweden & Norway, Belgium, France, Switzerland, Spain, Italy, Greece, Morocco, United States, Uruguay, British India, Canada, Cape of Good Hope, and Victoria (Australia). Bd of Tr Jour–Sept. 8500 w.

1626. Tramps as Human Beings. Morrison I. Swift, in *The Outlook* (An account of an experiment in giving employment to tramps as compared with another involving stringent penalties. The humane system said to be satisfactory and successful). Sci Am Sup–Sept. 28. 1400 w.

1627. The Thumb as an Initial Factor of Civilization. W. R. Whitehead (A very interesting speculation in which the power given to the human hand by the thumb, superior to that of the anthropoid apes, is considered one of the most potent factors in the elevation of the human race above the brute creation). Sci Am Sup–Sept. 28. 3200 w.

*1638. The Present Aspect of the Silver Question. Charles S. Fairchild (The author considers the situation encouraging to those known as "sound money" men, and cites signs in support of his opinion. He concludes that safety lies only in the severing of Government from currency to the utmost extent possible). Forum–Oct. 1500 w.

*1640. Demand and Supply Under Socialism. W. H. Mallock (An article examining the case of supply and demand, and the effect which the relation of these two factors has on values, prices and wages. Also showing that a society in which socialistic principles were developed would only aggravate the evils it aimed to correct). Forum-Oct. 8400 w.

†1669. How Men Become Tramps.—Conclusions from Personal Experience as an Amateur Tramp. Josiah Flynt (Causes or sources as understood by the author, stated, and remedies suggested). Century Mag–Oct. 4400 w.

†1670. The Marriage Rate of College Women. Milicent Washburn Shinn (A discussion of the facts of celibacy among college women. It may be a movement toward higher standards in marriage. No need to doubt that all good knowledge is safe in the long run for all men and women). Century Mag-Oct. 2500 w.

1718. The Treasury Situation and Congressional Action (Editorial, discussing the present financial situation and analyzing it. It declares that after the November elections the country will insist upon the abandonment of the policy of makeshifts, and upon legislation retiring legal tenders, which are an ever present menace to the maintenance of the treasury gold fund). Bradstreet's–Sept. 28. 600 w.

1719. The Bond Syndicate in History (Editorial reviewing the history of the bond syndicate, now terminated, which is characterized as one of the most unique, daring and comprehensive operations in the annals of finance). Bradstreet's–Sept. 28. 1800 w.

1720. The Quantitative Theory of Money Exposed (Editorial. Combats the theory that prices are regulated by quantity of money, contending that what does regulate prices is the state of credit). Bradstreet's–Sept. 28. 1200 w.

†1724. The Atlanta Exposition. W. Y. Atkinson (Some of the things which make the exposition worth visiting, even by those who have visited all past expositions). N Am Rev–Oct. 3600 w.

†1726. Some Problems of the Age. F. W. Farrar (Some of the problems and perils of this century, interestingly portrayed. The author concludes that the regeneration of society must come from individuals). N Am Rev–Oct. 3500 w.

†1727. The Microbe as a Social Leveller. Cyrus Edson (Teaching the truth that all men are dependent on each other; illustrated not only by prosperity, but disease, industrial development, &c). N Am Rev-Oct. 2500 w.

†1729. Is Socialism Advancing in England? W. G. Blaikie (Socialism, in its new aspect explained and its object stated. Concludes that in the sense used in this article it is not advancing). N Am Rev–Oct. 5000 w.

*1732. The Carnegie Libraries. William B. Shaw (Notes on a popular educational movement in "the greater Pittsburgh," with illustrated descriptions of the Carnegie free libraries of Allegheny and Braddock, and Carnegie library, music hall, art gallery and museum of Pittsburgh, which together form a complete library system). Rev of Rev–Oct. 4500 w.

*1733. The Civil Service Problem in Australasia. P. R. Meggy (Outline of a report of the New South Wales Civil Service Commission presented to the British Parliament, June 18, 1895. A very instructive article). Rev of Rev–Oct. 4500 w.

*1746. The Greenback Issue Is Returning. Jesse H. Jones (Predicts that the greenback question will soon again become prominent; declares that the "free silver movement" is a blind lead on a false scent; asserts that neither greenbackers, nor gold men have perceived their own errors, and have never refuted the truth maintained by their opponents; defines what the greenback really is, and presents its advantages). Soc Ec-Oct. 2200 w.

*1747. Protection by Bounty. Alexander R. Smith (An argument in favor of the so-called "Lubin proposition," with an editorial reply exposing its fallacy and the folly of adopting it. Those who wish to study both sides of the question will find the main arguments for and against protection by bounty, well and briefly put forward). Soc Ec–Oct. 2800 w.

*1748. Broader Trade Unionism (Takes the Position that trade unions are "not a social excrescence to be eliminated, but a social institution to be utilized and broadened." Indicates lines upon which their intellectual, social and moral expansion may be realized). Soc Ec–Oct. 2800 w.

†1752. War as a Factor in Civilization. Charles Morris (This paper maintains the contention that war has done more to advance civilization than the arts of peace). Pop Sci M–Oct. 6000 w.

*1762. Steam and Electricity—A Study in Sociology. A. A. Johnson (An attempt to seek a solution of the twentieth century problem, which the author terms "The World's Social Crisis. A consideration of the economic struggles and present social conditions). Am Mag of Civ–Oct. 7000 w.

*1763. The Decadence of Home-Ownership. H. L. Bliss (A reply to article by Gilbert L. Eberhart, published in the March number). Am Mag of Civ–Oct. 2300 w.

*1764. An Automatic vs. a Fiat Currency. E. L. Rector (Money defined; what determines its value; how value is secured; the two systems explained and contrasted). Am Mag of Civ–Oct. 6800 w.

*1765. A Financial Predicament. Henry B. Russell (Calling attention to influences affecting finances, and making some calculations as to federal finances under existing conditions of the new tariff). Am Mag of Civ–Oct. 2500 w.

*1766. The Single Tax: A Reply to Mr. Kitson. George Bernard (Pointing out obvious errors and setting forth what the author conceives to be a correct statement of some of the points at issue). Am Mag of Civ-Oct. 5500 w.

1775. How Strikes May Be Avoided (Describes the system of dealing with workmen and employés, in two cotton mills in Malaga, Spain, which is claimed to be a very striking example of how strikes may be avoided by obedience to the law of kindness. Abstract from report of David N. Burke, U. S. Consul at Malaga). Mach–Oct. 1700 w.

1784. Increasingly Favorable Clearings Totals (A tabulated statement of bank clearings at eighty-six cities for the month of Sept., for eighty-four cities during nine months respectively in 1894 and 1895, and for sixty-eight cities for four years. The most encouraging bank statement since the panic of 1893). Bradstreet's–Oct. 5. 800 w.

1785. The National Finances (An optimistic view, contributed by Worthington C. Ford, who believes that unless something very unexpected happens, there will be no deficit in the national revenues in the fiscal year ending June 30, 1896. A lengthy and able argument sustaining this view is presented). Bradstreet's-Oct. 5. 2000 w.

1786. Smaller World's Wheat Stocks than on July 1 (A tabulated statement showing that on Oct. 1, 1895, the available supplies of wheat in the United States, Canada and Europe and afloat for Europe, was only about two-thirds that on Oct. 1, 1894). Bradstreet's–Oct. 5. 800 w.

1787. The Australasian Banking Crisis (A survey of the history of this crisis, which reached its acute stage in 1893, and a review of the present status of Australian banks and banking). Bradstreet's–Oct. 5. 1000 w.

1831. The Management of Men. Herbert M. Ramp. (Shows that the tendency to specialism in molding is having a deleterious effect on the minds and habits of molders, and that want of mental occupation given by variety of work, is degrading the standard of molders. Also deals with the subject of apprenticeship and treatment of apprentices). Ir Tr Rev–Oct. 3. 2000 w.

*1855. The Average Wages of British Workmen (Review of a report on this subject issued by the Board of Trade). Engng–Sept. 27. 2800 w.

†1865. Why the Workers Want. Robert Grieve (An article proving that wages bear no necessary or constant relation to the profits of business. Setting forth the wrongs due to monopolies. Examples of the power of capital, and its tendency to result in socialism). Arena–Oct. 3600 w.

†1866. Woman's Discussion of the Labor Problem. I. Land and Money. Julia A. Kellogg. II. Solution of the Labor Question. Charlette P. Stetson. III. The Great Neighbor. Alice T. Post (The opinions of representative women on social problems. A Symposium). Arena–Oct. 3800 w.

†1867. The Significance of Labor Day. Eugene V. Debs (A brief consideration of the design of all holidays, and the endeavor to point out the best use for wage-earners to make of Labor Day). Arena–Oct. 1800 w.

†1868. Manual Training for Women and the Problem of Domestic Service. G. Vrooman (An account of the schools of this character in Europe —Switzerland leading in the number and excellence of the schools—France not far behind. The advantages of such schools set forth. The present unfortunate condition of inefficiency in domestic service, due to its never having been dignified as a trade, etc.). Arena–Oct. 3200 w.

†1869. Industrial Reform. James G. Stevenson (Suggestions given in the hope of presenting a programme of industrial reform in which all classes of society may unite). Arena-Oct. 2000 w.

†1886. The Regulation of Prices (Editorial. The great need of disposing of goods at prices which will save the producer from loss. The natural tendency of prices is downward. Some suggestions to aid the seller in getting the value of his goods). Ind Rub Wld–Oct. 10. 1500 w.

MARINE ENGINEERING

Education of Naval Engineers.

In the *Journal of the American Society of Naval Engineers* for August, Passed Assistant Engineer F. L. Bieg, U. S. N., discussed the necessity and value of scientific research in naval engineering matters as related to the United States navy, and the necessity of an engineering training for the younger members of the engineer corps. This paper appears to have been of sufficient interest to call out a very thorough discussion of the proposition made in it, which is, in substance, the establishment of a government experimental station, or school, modeled somewhat after the English naval experimental station, but on broader lines. The establishment of such a station would be far-reaching in its effect upon both the navy and the merchant service; and, as the approval given to the proposal by members of the society indicates that a determined effort to have it carried out is likely soon to be made, we quote the outline of the scheme as set forth by the author of the paper.

"The school should be at some place where there is still and deep water (as many of the experiments will be made with boats) and at a reasonably convenient distance from the manufacturing and engineering centers. There should be an engineer officer of rank in charge, under the immediate direction of the chief of the bureau of steam engineering. To put this school in a navy yard, where the officers attached to the yard are subject to all kinds of duty, would load it with useless routine and be disastrous to good results. As the experimenters are to be engineer officers, it would be just as well to encourage *esprit de corps* and stimulate the efforts of individual engineers by putting them directly under officers of their own profession, thoroughly conversant with the engineering needs of the service. With the officer in charge, who might be styled the director, should be associated two or three officers, whose duties will be defined further on. The number of officers will, of course, depend on the other demands of the service. The testing outfits and apparatus for the standardization of indicators, gages, and other instruments now at the New York navy yard should be kept at this school."

"Whenever an engineer officer has a plan for the investigation of any subject in practical engineering, chemistry, metallurgy, on propellers, lubrication, boiler deterioration, or any of the many other points directly connected with, or useful to, naval engineering, he would submit it to the chief of the bureau of steam engineering, through the regular channels, giving his ideas and the scope of the investigation as fully as may be necessary to a clear understanding. Should the bureau approve his plan, or think the matter worthy of experiment, the officer would then be detailed to the school, as soon as the exigencies of the service permit. In case of approval, no radical change in the applicant's proposed method of investigation should be made, as he should be given credit for his ideas and allowed to carry them out in his own way. Should any change in the method of the subject be deemed advisable, the applicant should be notified before the plan is approved. There is no use in ordering any one interested in a particular subject to investigate it in any radically different way from his own, for it deprives the experimenter of that personal interest without which there will be no success. Should the bureau or the director at any time wish to make original tests or experiments, engineer officers could be ordered as at present, if any are necessary in addition to the officers stationed at the school."

A course of instruction for the assistant engineers just after their promotion from naval cadets, and a museum "of engineering models, metals, instruments, and supplies," are also suggested as a useful complement to the scheme of the experimental station. The founding of such a station would, at small expense, enable "the excellent work of Isherwood, Loring, Thurston, Emery, and other American naval engineers" to be carried on "systematically and intelligently."

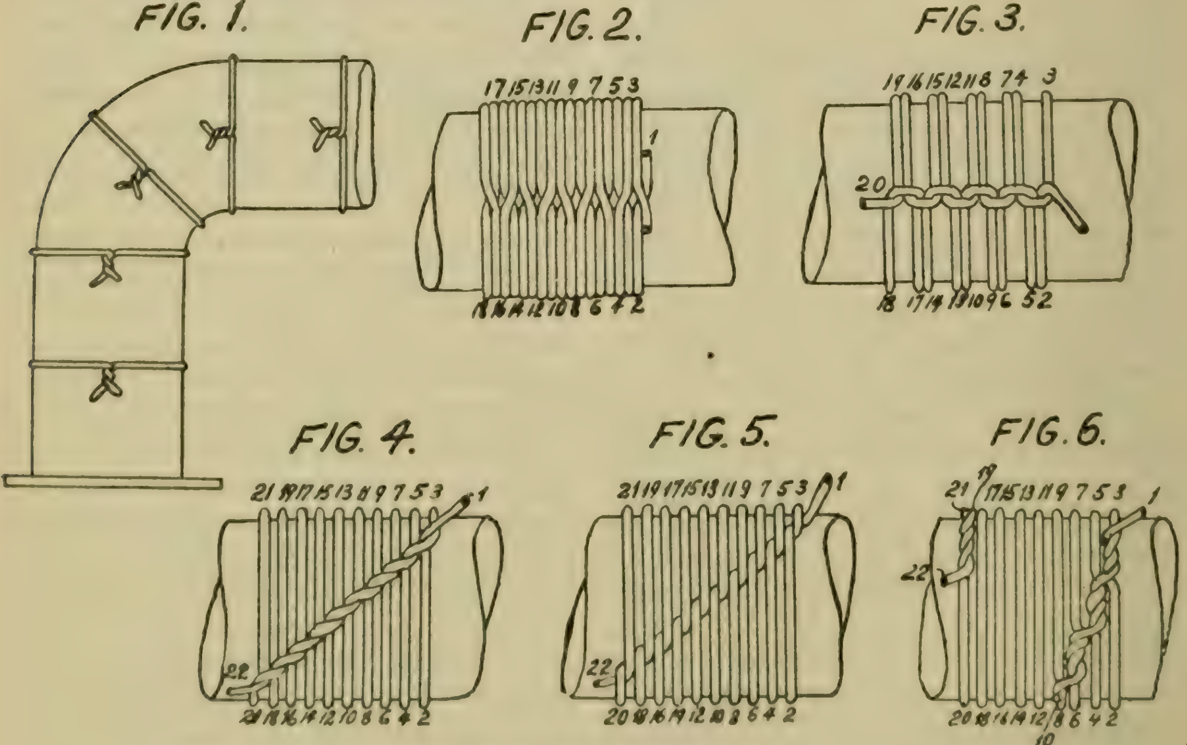
It is seldom that a paper of any sort is complimented by so hearty an approval and so lengthy a discussion as was bestowed upon this one. The approval of the scheme was not only well-nigh unanimous, but enthusiastic.

Tests of Wound Copper Pipes.

In these tests, made at the Imperial Dockyard, Wilhelmshaven, Germany, and reported in the *Zeitschrift des Vereins Deutscher Ingenieure* by Chief Engineer Kohn non Jaski (translated for the *Journal of the American Society of Naval Engineers*), copper pipes having respectively an inside diameter of 7.87 and 11.81 in., and a thickness of 0.295 and 0.413 in., were used. According to the formula $t = \frac{pD}{5689}$, these pipes were suitable for a working pressure of 213 lbs. per square inch, and thus a factor of safety of at least ten was adopted.

The hydrostatic pressure in five of the tests was carried only far enough to destroy the wire rope used in winding the pipe. The rope was simply coiled around the pipes, which were made to order in Berlin by C. Heckmann. Twenty test pieces from strips cut from the ends, and in a direction at right angles to the axis, showed an average tensile strength of 31,106 lbs. per square inch and an elongation of 25.2 per cent. in a length of 7.87 in., and, after annealing a tensile strength of 30,537 lbs. and an elongation of 35 per cent. Cold bending and forge tests gave satisfactory results; the material of the pipes was of the best quality.

Copper wire ropes proved too ductile; and, notwithstanding the great weight and cost of these ropes, the sides of the pipe were not well supported, and considerable expansion resulted. As the result of conclusions derived from experiments with copper wire rope and with galvanized steel rope of lesser diameter, galvanized steel ropes 0.2952 in. in circumference were used for the 7.87-in. pipes and the 0.3937-in. pipes. "The various windings shown in Figs. 2 to 6 were used, and the pipes subjected to a hydrostatic pressure. As a matter of fact, the bights in the different windings were close together, as shown in



METHODS WINDING COPPER PIPES.

Fig. 2; in the other figures, they are shown separated, in order to make the method of winding clearer. The figures indicate the direction of winding. After the breaking of the first bight in Fig. 2, the adjacent parts of the same winding were held in place by the other rope, wound in the opposite direction. But, as soon as a bight of this second rope broke near the first place, all bights for a distance of 2.9 to 4.7 in. either side of it became loose."

In the winding shown in Fig. 3 eight adjacent bights broke at a pressure of 1877 lbs. per square inch, the rope being very unfavorably strained because of the knotting. After the first bight in the winding shown in Fig. 4 gave way, the adjacent ones loosened on the pipe, but again tightened as the pipe expanded. In the winding shown in Fig. 5 the bights next to the place of fracture became looser than in the last-named winding, but they also tightened again under the expansion of the pipe.

"In the winding shown in Fig. 6, the first bight broke at a pressure of 2418 lbs. per square inch, the adjacent bights remaining perfectly tight. After increasing the pressure to 2560 lbs., other bights broke, but all adjacent ones remained tight. Where the rope XX broke, the pipe expanded, and a number of other bights broke at pressures of 1422 and 1707 lbs., but all bights which were not broken remained tight around the pipe. In test 17, with the same kind of widening, being a parallel test to 8, the first bight broke at 2707 lbs. The pressure was then increased to 2958 lbs., when other bights broke. The behavior of the bights was the same as in the preceding test. Accordingly, the method of winding shown in Fig. 6 proved to be the most satisfactory, and from its behavior could be designated as thoroughly reliable for use on ship-board."

The following is the substance of rules adopted as a result of these tests, and promulgated to the German navy. (1) The maximum stretch to which any copper pipe may be subjected is fixed at 2844 lbs. per sq. in., and the strength due to winding must be eliminated from the calculation. The minimum thickness is fixed at 0.157 in. (2) Pipes must be either solid drawn, or made of sheet copper with double butt straps and riveted. All pipes above 4.72 in., and used for steam pressures of 100 lbs. and over, must be wound as indicated in Fig. 6, the table below giving the sizes of ropes required for pipes of different inside diameters.

Inside diameter of pipe. In.	Circumference of steel wire rope. In.
4.72 to 5.9	0.2952
6.10 to 7.87	0.3937
8.07 to 9.84	0.492
10.03 to 11.81	0.5906
12.00 to 13.77	0.6889
13.97 to 15.74	0.7874

(4) All main steam pipes of sizes indicated in the table must have flanges riveted on, not brazed.

Electrical Canal-Boat Towage.

In a communication to *The Engineer* (London,) Mr. Geo. Cawley clearly exposes a principle which should govern attempts at applying mechanical power derived from any source to boat-haulage; and he also describes and illustrates an electric locomotive and a track by which the principle may be carried out. He maintains that the "ideal form of general electric haulage for canals should, in this mode of operation, be as nearly like horse haulage as possible; that is to say, the haulage should be effected through a towing line, as by this means we can increase the efficiency of haulage and insure minimum damage to the canal banks. When a fairly high speed is maintained by a screw tug-boat in the confined channel of a narrow canal, it is only done by a relatively great propelling power, and, unfortunately for the canal banks, the excess of power required by the boat in a narrow canal above that necessary for the same speed in open water is largely spent in promoting destruction. A considerable portion of this destruction is due to the action of the propeller and the consequent wash upon the banks. Any method of electric haulage which requires the use of a submerged propeller, therefore, does nothing to reduce this cause of commercial loss to a canal company, while it is also unsuitable for dealing with shallow draught boats.

"The foregoing considerations support the contention that the ideal power haulage system for canals should be based on the towing-line principle; for, if energy equal in amount to that developed by the steam or electric motor driving a screw propeller were transmitted through a towing line from an electric locomotive travelling along the canal bank, the advantages gained over the submerged propeller system would be as follows: (1) reduction in percentage of wasted energy; (2) reduction of the wash, and consequent damage to the canal banks; (3) capability of applying haulage power to boats of even the smallest draught.

"Had the electric haulage plant unsuccessfully tried on the Erie canal been on the towing-line principle, the difficulties arising from the shallow draught of the boats would not have arisen. It should, however, be stated that, in order to make the towing-line haulage system of general application, it should fulfil the following conditions: (1) the haulage locomotive should not require a driver, and it should be controllable from the boat; (2) the up-and-down locomotive track should not seriously interfere with the present towing path as regards horse-haulage; (3) the locomotive should be able to pass along the whole length of the canal,—that is, through tunnels or under bridges, over public roads which cross the canal route, and along the steep slopes in the vicinity of some locks; (4) the general working economy of the system should be superior to the haulage now commonly used on canals."

The general character of the system of electric towage presented by Mr. Wheeler is that of two elevated-railway, single-rail tracks, each supported by brackets projecting from the sides of posts, and one far enough above the other to allow motors on one track to pass those on the other. The tow lines are attached to the bottoms of the motors and are attached to boats. They would be generally used in hauling in precisely the way in which they are now used in towing with horses or mules. An arrangement whereby the motor driving wheels are made to press upon the rails sufficiently to get the required traction seems adequate for this purpose, and the motors can be made light. As the track passes well above public highways, interference with traffic on the latter will not need consideration.

THE Committee of works of the Mersey docks and harbor board has decided upon some extensive alterations and improvements at the Foreign Animals Wharf, Birkenhead. In connection with the cold air stores there is to be a complete renovation on the Linde system of the refrigerating machinery, a large portion of which is of an antiquated description. An additional chill-room, to be kept at a uniform temperature of 33 deg. Fah., is to be constructed.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*1306. Transatlantic Steamships of 1856 to 1880. Ill. Samuel Ward Stanton (A quarter century's progress in ocean travel, from the Great Eastern to the first steel steamships). Eng Mag-Nov. 4000 w.

1319. The Evolution of the International Racing Yacht. Ill. J. B. W. (The series will trace in a brief way and with the aid of diagrams, the development of the racing yacht in the last ten years, and will show the evolution from American sloop and English cutter of the present accepted type). Sci Am-Sept. 14. Serial. 1st part. 1600 w.

1342.—$1.25. On the Necessity and Value of Scientific Research in Naval Engineering Matters as Related to the U. S. Navy, and the Necessity of an Engineer Training for the Younger Members of the Engineer Corps of the U. S. Navy. F. C. Bieg (Deals with the desirability of a government experimental station, and the aid which such a station would afford to marine engineering in the United States). Jour Am Soc Nav Eng-Aug. 13500 w.

1343.—$1.25. Experiments in Connection with Evaporation. Ill. D. B. Morison (One of the most exhaustive, practical and theoretical discussions of the subject that has yet appeared in print). Jour Am Soc Nav Eng–Aug. 6500 w.

1344.—$1.25. Curves showing the Relation Between Equivalent Hollow and Solid Shafts. W. F. Durand (Defines equivalent shafts as those that will carry equal turning or bending moments with equal outer fibre stresses. States the advantages of hollow shafts as compared with solid ones, with formulæ for computing, and a diagram wherein, by curves, equivalent shafts are indicated). Jour Am Soc Nav Eng–Aug. 600 w.

1345.—$1.25. Test of Wound Copper Pipes. Ill. (A very important and interesting practical paper describing results of experiments with wound copper pipes, the winding being performed by different systems. Results tabulated). Jour Am Soc Nav Eng–Aug. 2400 w.

1346.—$1.25. Remarks on Steam Pipes. J. T. Milton. (A valuable contribution to the literature of this subject now undergoing thorough investigation, with a view to the attainment of greater safety under modern high pressures. Presents many points of interest). Jour Am Soc Nav Eng-Aug. 4200 w.

1350. The Ship Canal Illusion (A strong editorial against the policy of constructing a ship canal connecting the Great Lakes with the Atlantic). Sea–Sept. 12. 2200 w.

1377. Impregnable Armour Plate. From *N. Y. Sun* (Accounts of a government test, primarily a test of steel armor plate, but really a trial of the strength of the frames of modern war-ships, which it had been claimed could not withstand the shock caused by heav projectiles against the armor covering them). Eng–Sept. 14. 900 w.

*1427. Fitting Machinery in Screw Steamers. Ill. (This first number indicates that the subject will receive a thorough, practical treatment). Eng, Lond–Sept. 16. Serial. 1st part. 1100 w.

*1428. Dredging Vessels for the Russian Imperial Government. Ill. (Description of the latest of five dredging vessels constructed for the Russian government). Eng, Lond-Sept. 6. 500 w.

*1449. The New Glasgow Docks. Ill. (Full description of the new tidal dock on the south side of Glasgow harbor, constitutes the first number). Engng–Sept. 6. Serial. 1st part. 2000 w.

*1453. Shipwrecks, British and Foreign (A review of Lloyds' record of shipwrecks, recently issued). Engng–Sept. 6. 900 w.

*1455. Water-Tube Boilers in the Navy (A series of communications criticising water-tube boilers for marine use, and claiming that they have not yet passed out of the experimental stage ; exemplifying the argument by instancing the record of such a boiler during two voyages of the Wilson liner, Ohio, etc). Engng–Sept. 6. 5500 w.

†1471. Ship Lights. A. Ewbank (A mathematical analysis of the effect of changing position upon estimation of the danger distance by observation of lights at sea. An alleged rapid method of making such estimation). Ind Engng–Aug. 24. Serial. 1st part. 1800 w.

*1509. The Composite Screw Steam Tug "Sir Frederic." Ill. (Descriptive ; also presents indicator diagrams. Steam 162 lbs. vacuum 26 in. ; revolutions 124). Engng–Sept. 13. 1300 w

*1511. The Torpedo-Boat Destroyer "Sokol" (Descriptive and critical. Shows how the use of new metals and appliances have made it possible to increase lightness and speed). Engng–Sept. 13. 1800 w.

*1547. Changing Propellers Afloat (Describes the removal of a broken propeller and replacing it by a new one on a steamship while afloat by emptying after ballast tanks and filling her fore peak with water, thus lifting her stern tube to the surface). Prac Eng–Sept. 13. 900 w.

1637. Resources of American Shipbuilders. Ill. (Will give descriptions of American ship yards and ship building firms. This number describes the establishment of the Craig Shipbuilding Co., Toledo, Ohio). Eng–Sept. 28. 700 w.

†1730. Our Need of Stringent Shipping Laws. Frank Rotherham (The establishment of fast transatlantic steamship lines under the American flag makes the call imperative. British laws cited as securing the protection and security felt in their vessels. Instances illustrating the necessity). N Am Rev–Oct. 1200 w.

*1835. A New Steam Lifeboat (Editorial. Performance of a new hydraulic propelled steam lifeboat. The belief is expressed that in this boat exists the type of the lifeboat of the future. This is the second boat of this type yet constructed, *Duke of Northumberland* being the first, and the description given of her hull, engines, and propelling apparatus applies equally to both boats ; the latest differing only in being somewhat larger). Eng, Lond–Sept. 27. 1500 w.

*1836. Presidential Address of Mr. Durston before the Institute of Marine Engineers (Discusses water-tube boilers for naval use, gives reasons for their adoption in the British navy, naming examples of vessels fitted out with them. Also discusses the subject of leaky tubes, with a review of experiments performed to discover causes and remedies for leaking ; touches upon the topics of bursting boiler tubes, proportions of boilers, draught systems and general requirements for training officers, etc). Eng, Lond–Sept. 27. 3300 w.

*1837. The Effect of Wind and Atmospheric Pressure on the Tides. W. H. Wheeler (Read before Section G of the British Asso. The author thinks the wind blowing at any particular port a much more reliable guide to height of tides than barometric pressure, and gives interesting facts in support of his view). Eng, Lond–Sept. 27. 2500 w.

*1854. Navy Boilers (Editorial review of Mr. Durston's address before the Institute of Marine Engineers. Containing also a spirited criticism of the action of the British Admiralty upon the subject of water tube boilers). Engng–Sept. 27. 1800 w.

1856. The Port Royal Dry Dock. Ill. (Detailed description of a new timber dock, comprising features different from the new Port Orchard timber dock, and from the Simpson timber docks). Eng Rec–Oct. 5. 1400 w.

MECHANICAL ENGINEERING

Progress in Steel Castings.

AT the last meeting of the American Society of Mechanical Engineers a paper was read by Mr. M. H. L. Gantt (*Practical Engineer*, which gave an outline of the history of the young art of making soft steel castings, and added some interesting information relating to its present status.

"The first soft steel castings, such as are used for gun carriages that are made in this country, and which were subjected to a ballistic test, were made in 1886 and 1887 by the Midvale Steel Company, who were the pioneers in this work. The ballistic test was considered severe at that time; but to-day the ordinary soft castings made by almost any one of a dozen of the best steel-casting companies would pass it successfully." Steel castings were, however, made in this country at an earlier date. In July, 1867, "the William Butcher Steel-works, now the Midvale Steel works, cast some crossing frogs for the Philadelphia Railroad of crucible steel. The molds were made of ground fire-brick, black-lead crucible pots ground fine, and fire-clay, and washed with a black-lead wash. The surfaces of these castings were very smooth, and the metal, which was practically tool-steel, was so well adapted for the purpose that some of the castings made in those early days are said to be still in use.

"This was before the use of silicon for solidifying steel was known, and the castings were very much honeycombed in all parts, except the wearing surface of the frogs, which was 'cast down.' The possibility of getting one face of a casting approximately solid admitted of the use of steel also for hammer dies, although their general sponginess was a great obstacle to their extensive adoption."

But it was not discovered until later that many of the imperfections in steel castings were directly caused by pouring the metal when not sufficiently hot. This finally becoming apparent, another step in advance was taken. It was in small castings that the imperfections were chiefly apparent, and there were and are difficulties in "getting uniformly hot metal in an open hearth furnace. The delay caused by a slow or difficult tap of the furnace, which is always liable to occur, is fatal to the production of the best castings. . . . Cold metal in the ladle is to-day the cause of more complaint by purchasers, and expense to the manufacturer, than anything else in connection with the manufacture of steel castings.

"As long as castings were small, the molding mixture of ground brick, ground pots, and fire-clay was satisfactory; but, on large castings made with that facing, the surface was very imperfect, and the sand adhered to it with great tenacity. But little improvement in the method of molding was made for some time, and, while the quality of the steel was gradually improved, the appearance of the castings was decidedly against them, and but little progress was made in their introduction.

"The next step taken by the Midvale Company was to leave the ground pots out of the molding mixture, and to wash the mold with finely-ground clay fire-brick. This was a great step in advance, especially in heavy castings, and a marked improvement took place in their general appearance; but the mixture still clung so strongly to the casting that only comparatively simple shapes could be made with certainty. A mold made of such a mixture became almost as hard as fire-brick when dried, and offered so much resistance to the proper shrinking of castings that, when at all complicated in shape, they had so great a tendency to crack that their successful manufacture was almost impossible. The next step was to use a mixture of silica sand and flour. In small castings this gave pretty good results, as such a facing cleaned off the casting very readily, leaving a smooth surface much superior in appearance to that left by the ground brick. The great difficulty in the way of the extended use of such a facing was the tendency of the flour to burn in drying, leaving the sand without a proper bond; and often the burnt mold was so friable as to be entirely useless. In the case of large castings it was almost impossible to dry thoroughly the whole mold without burning that portion nearest the fire, and for such work flour was necessarily abandoned." By this time the use of silicon for solidifying castings was coming into general use, and the only obstacle in the way of making good steel castings was the want of a suitable molding sand. This was ultimately found in a mixture the principal constituents of which were silica sand and molasses ground together.

The improvement in the appearance of castings caused by the use of sand that left a clean, smooth skin was the cause of their rapid adoption; and the year 1887, when the Midvale Steel Company made the first gun-carriage casting of steel, is approximately the date at which their rapid extension began.

Dealing next with theoretical explanations of some of the troubles traceable to the use of insufficiently-heated metal, Mr. Gantt concludes this part of the discussion with a very encouraging statement. "That shrinking holes and cracks do still occur in steel castings is well known, but the success that founders have had in casting complicated shapes within the last year or two has been surprising. The fact that a steel casting must cool at the bottom first, and then gradually upward in the mold, is being learned by designers; and shrinkage holes are becoming less frequent, for the founder at once fixes on the heaviest portion of his sink head, which is usually about 20 per cent. of the total weight of the casting, and which must remain fluid until the whole of the casting proper is solid."

As to designing forms for steel castings, the rule that,as far as possible, they should be of uniform thickness throughout holds with even greater force than for forms to be made of cast iron. By adherence to this rule castings of steel are now made 20 ft., long by 10 ft. wide. Such castings would have been thought impossible only a few years ago.

Experimental Study of Belt Lacing.

We present in the form of an abstract the results of experiments which will go far toward settling the question of the best way of lacing belts,—experiments described in an article by Walter Flint, M. E., of Maine College, Orono, Me., in *American Machinist* (Sept. 5). The experiments were directed to the ascertaining of strength only, wear not being considered. It would be desirable to have these tests supplemented by tests in actual running under stresses approximating those used by Mr. Flint, because there is no warrant beyond mere inference for assuming that the results would be the same in both cases, or even that they would be relatively the same. Such supplementary tests, to be accepted as conclusive, ought also to be made on pulleys of large, medium, and small size, to determine effects of flexure upon the durability of the different lacings, and with tensions such as are considered proper in actual practice. The experimental method is the only one whereby the truth in this matter can be reached.

The tests were made with 4-in. beltings. "Five holes were punched ¾ in. from the end for a single row of holes, and for a double row of holes the second row was 1½ in. from the end. The punched holes were $\frac{3}{16}$ in. diameter. These five holes removed $\frac{15}{16}$ in. from the width of the belt. The belt being 4 in. wide, the net section is about 76 per cent. of solid belt, while, in the cases where the holes were cut with an awl, the net section is theoretically about the same as the solid belt.

"The apparatus for holding the specimens was so constructed that the belt was free to move as though it were on pulleys, thus equalizing the strain in that direction. It was then held in the testing machine by hooks which allowed it to stretch more on one side than on the other if it wanted to. This latter condition is not strictly true of a belt on pulleys, but, considering the very short length of the samples, it was thought best to have it so in these tests.

"(Nos. 1 and 1*a*)—The form of this joint is plainly shown in cut No. 1, and No. 1*a* shows the break. The belt was not injured. The lace broke in the middle first, and then on the edge. The joint failed under a tension of 1150 lbs. Since the net section should hold about 2065 lbs., it is clear that more laces should be put in.

"(No. 2.)—This is the same form of joint as No. 1, except that the holes were made with an awl. It was not thought worth while to photograph this one before testing. It will be noticed that the lace cut the belt from the holes in various directions. The lace did not fail till after the belt failed on the lower side. The joint failed at 790 lbs., and the form of the break shows that the failure was due to the form of holes rather than weakness of belt.

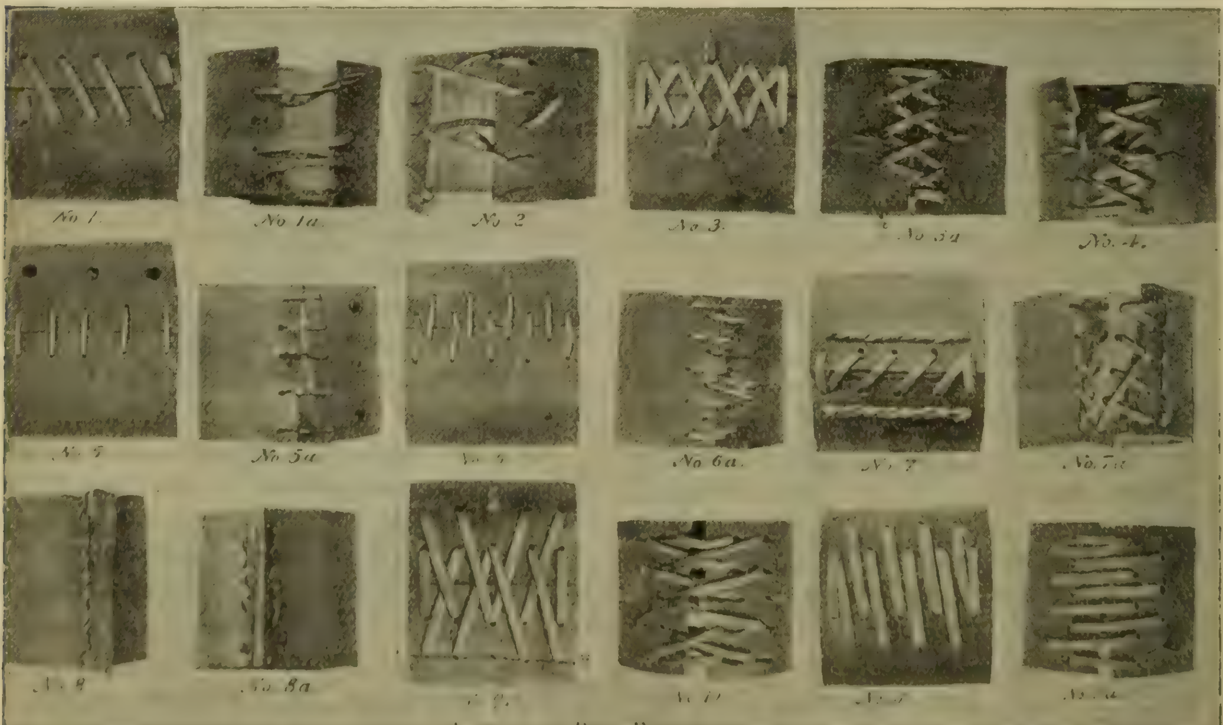
"(Nos. 3 and 3*a*)—Same number of holes and punched same as No. 1, but double laced, as shown in cut No. 3*a*, at *c*. The lace was not broken. Tension applied, 1460 lbs.

"(No. 4)—Exactly the same as No. 2, except that it was double laced as No. 3. Tension applied, 1335 lbs. It failed by the lace cutting through the belt. Shape of holes was cause of failure. The lace was not injured. These tests would seem to show that holes cut with an awl are far inferior to punched holes.

"(Nos. 5 and 5*a*)—This was a trial of one of the metallic fastenings. The fastenings being 1 in. long, the holes had to be made ½ in. from the end of belt. No. 5*a* shows the broken joint. Tension applied, 725 lbs. Two of the hooks broke, one straightened out, one pulled through the belt, and one remained sound, thus showing failure of both belt and fastenings.

"(Nos. 6 and 6*a*)—Same as No. 5, except that by staggering the holes four more hooks were put in. No. 6*a* shows the broken joint which failed under a tension of 1480 lbs. Both belt and fastenings failed.

"(Nos. 7 and 7*a*)—Cut No. 7 shows this form of joint. Holes punched. The break is shown in 7*a*, and took place at 1510 lbs. The lace failed in one place, while the belt failed generally.



A Study of Belt Fastenings.

"(Nos. 8 and 8*a*)—This is known as the "boot leg" lacing, and is a great favorite in Eastern Maine, because of its durability. Of course it cannot be used with a tightener or in many other places. No. 8*a* shows the break which occurred in the lace; the belt itself had started to tear in several places on the inside. Tension applied, 1310 lbs.

"(No. 9)—This is a double laced joint, with only one strand in each hole. Holes punched. The negative of the broken specimen was lost, but the break occurred along the line *A B*. The lace was not injured. As nearly as could be observed, the break was simultaneous along *A B*. Tension applied, 2015 lbs. The net section of belt should have held about 2065 lbs. This would seem to show that nothing further can be obtained when five $\frac{3}{16}$-in. holes are used, since the lace held more than the belt.

"(No. 10)—Same as No. 9, except that the holes were cut with an awl. It was thought, since No. 9 failed on account of too small a net section, that making holes with an awl might possibly help matters. The cut shows the result. The lace was not injured. Tension applied, 1590 lbs.

"(Nos. 11 and 11*a*)—No. 11 is peculiar, in that the holes are staggered, one strand in each hole, and strands not crossing on either side. There appears to be no reason why it should not hold as much as No. 9. The lace was evidently faulty, since the hole did not appear particularly strained. No. 11*a* shows the broken lace, on the lower side. Tension applied, 1835 lbs. This comes the nearest to No. 9 in strength."

Coal Gas as Motive Power for Self-Propelling Road Vehicles.

THE probable near removal of restrictions upon the use of self-propelled vehicles on English public roads leads the *Journal of Gas Lighting* to urge "the ingenious to apply themselves with all the ardor that opportunity affords to the production of such self-propelled vehicles as may appear likely to obtain, first of all, a share of the premium offered by the *Engineer*, and afterwards an even more remunerative need of public patronage."

As a motive power compressed gas offers marked advantages for this purpose. It has been applied with remarkable success at Dessau for propelling street cars on tramways, and the analogy of this use to that of moving vehicles on common roadways will be at once admitted. "Gas power is well to the front as a means of driving tramcars; and there is no apparent reason why it should not answer as well off as on the rails. . . . The electricians appear to be flattering themselves that the solution of the problem is in their hands; but the evidence in support of this supposition is extremely slight. Even for working tramcars, electricians can do nothing without the objectionable trolley wire, which is, of course, impossible for free road traffic. Their only aid to free carriage driving is the accumulator, which has never yet succeeded in justifying itself for this application, notwithstanding the tens of thousands of pounds that have been spent in experiments with this ponderous and inefficient means of propulsion. The most successful self-propelled road carriages yet made have been driven by steam or petroleum-spirit engines, especially the latter; and it is with the best of these that the adapters of gas motors to the new application will have to compete."

"It remains to be seen whether naphtha or compressed gas is preferable on all accounts as a portable source of energy. For compactness there is probably nothing to surpass petroleum spirit; and, if Mr. Maxim's judgment in the matter of driving his flying-machine is worth anything in this connection, it may be better to burn the spirit as a fuel for raising steam than to gasify it for use in an internal combustion engine. Naphtha and spirit, on the other hand, are dirty, and are not devoid of risk in handling or using. A cylinder of gas, on the contrary, is incapable of making a mess; and the risk of carrying and handling it is certainly less than that attaching to volatile mineral spirit. It must not be forgotten, moreover, that the noble animal, the horse, whose place between the shafts is to be taken by the engine carried in the body of the conveyance, is not free from little tricks of his own. The subject of risk, indeed, hardly enters into the discussion of the suitability of compressed gas for driving vehicles. A certain, or rather uncertain, amount of danger attaches to the use of every appanage of material civilization; and, unless this amount can be proved to be materially increased by any particular appliance,—which is not the case with compressed gas motor engines,—there is no need to regard it as affecting the issue." Inventors and designers will do well to look over the whole field of motors for light propulsion both on land and water. Compactness is one of the chief requisites of the road-vehicle motor; yet this must not be taken to mean that compactness over-shadows other important qualities, which are in great measure the same as those belonging to all motors used to propel comparatively light vehicles or boats.

False Economies in Foundries.

MR. H. HANSEN read a paper before the late convention of the Western Foundrymen's Association (*The Iron Age*, Sept. 26) in which he maintained that the term economy poorly fits too many of the savings made in the foundry. In this paper and the discussion elicited by it several significant facts are made apparent. One of these is that, as the manufacture of foundry tools is becoming a trade in itself, and "the men engaged in it are bending every energy toward developing superior appliances for the foundry," it is, as a rule, a false economy for foundrymen to manufacture their own tools. Another false economy is in the use of makeshifts, although there may be exceptional jobs and conditions that may justify a resort to them. Cheap men and cheap iron were named as false economies. The cheap iron may be found "cheap to get out of the foundry," but it will be dear when it gets into the machine shop. "Cheap men make poor castings and have to make them over again."

Mr. John Pettigrew said: "It is only about 6 months ago that I first bought '*made*' chaplets. We were making our own chaplets, and we lost a great many castings from their not being properly made. After we had bought the first lot, for, I think, 60 cts. per one hundred chaplets, I commenced to figure up the cost of the chaplets we had been making and found it had been $2.50 per hundred, and they were not so good."

Mr. Hanna questioned whether anybody ever made anything by working nights and overtime. He believed that it is economy to run a plant at its full legitimate, capacity, but a false economy to attempt to exceed capacity. A cheap foundry foreman was named by another member as one of the false economies of foundry practice. In the office and counting room there appears to be also some defects. Mr. J. A. Brady criticised methods of purchasing. He said: "I have been connected with foundries where they did all their buying in the office. Perhaps some young man gets into the office, and he is put in the position of buyer. Somebody comes along with iron that is 50 cents a ton cheaper. He will buy it and ring it in on the foreman. Perhaps he will try to pass it off as another brand, as another iron. The same is true with coke. It has occurred in my experience that buyers would give me very inferior iron and coke and try to pass it off on me as good, when I knew, and they knew, that it was inferior. They were giving me those cheap things, and expected the same results as with good materials."

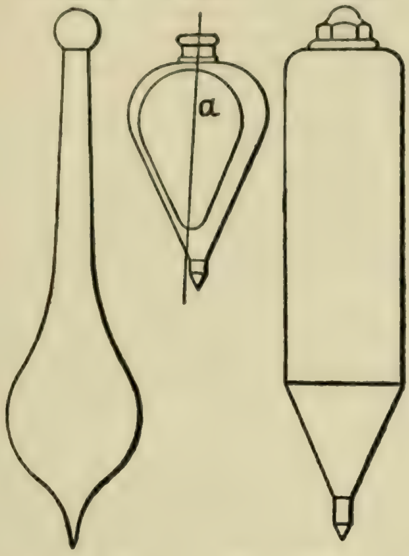
A Word About Plumb Bobs.

IN an article on erecting and starting steam engines, by "Spike" in *Machinery* (New York, Oct.), some useful hints regarding the plumb-line and plumb-bob are given. This implement, when well-made, ought to be classed among tools and instruments of accuracy; but "Spike" shows that, as ordinarily made and kept on sale in the hardware and tool stores, it is an instrument of inaccuracy. He says:

"The first plumb-bob that I used was the regulation hardware store arrangement familiar to all (see Fig. 1), and it got me into lots of trouble. It was brass, cast hollow, and filled with lead, and the brass was about $\frac{5}{16}$ in. thick on one side, or $\frac{1}{32}$ in. on the other. The lead, being heavier than the brass, brought the center of gravity to one side, or on a line *a* (Fig. 1), and the shape kept it well up; consequently the error was magnified considerably at the point. That plumb-bob met with an accident, or I probably should have never known how it was constructed or why its point would scribe a circle if it got to whirling. Then I made one like that shown in

Fig. 2, of a piece of steel 1⅛ in. diameter by 4 in. long, which I considered all right, and used it for a long time, with lots of good chances to give it away, which I finally did, and then made one like that shown in Fig. 3, which I thought couldn't be improved upon; but I am going to make one more, and it will be like the last named, only 9 in. long, while that shown in Fig. 3 is only 5 in. long. The new one will have a long, slim neck of ¼ in. diameter, and will be of tool steel instead of soft steel. For lines use braided silk, and in the long run you will find it much cheaper, and better satisfaction will offset the extra cost."

FIG.3 FIG.1. FIG.2.



On the announcement of the death of Mr. George W. N. Yost, inventor of the Yost typewriter *American Machinist* says: Mr. Yost was born in the western part of this state sixty-four years ago. His father was a farmer, but the boy early developed mechanical tastes, and found employment in the shops then building the Acme mower and reaper. He suggested various improvements and secured an interest in their manufacture. Later his inventive abilities produced the typewriter. From this he is said to have realized a fortune, which he lost in various speculations. He later organized a typewriter trust and accumulated a second fortune, but is said to have died a comparatively poor man.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Technical Journals—See Introductory.

The Machine Shop.

*1307. The Prevailing Scarcity of Skilled Labor. A. E. Outerbridge, Jr. (Showing that the development of industries due to new inventions has enormously increased the demand for skilled labor). Eng Mag-Nov. 4000 w.

*1318. Core Making. Ill. Joseph Horner (Subject practically treated with illustrations of a variety of cores for special purposes). Mech Wld-Sept. 6. Serial. 1st part. 1900 w.

1325. Some Good Steel Castings. Ill. Gus. C. Henning (Describes steel castings of large size which show a great advance in the state of the art as compared with castings made only a few years ago). Am Mach-Sept. 12. 700 w.

1327. Architect's Machine Design (A criticism of design of a machine, made by an architect of reputation, and general editorial remarks on the subject of machine design). Am Mach-Sept. 12. 700 w.

1428. Ring Oiling Device for Bearings. Ill. M. A. Chine (Describes a ring oiling device for bearings of shafting which appears to have great merit, and discusses, practically, ring and other oiling devices). Am Mach-Sept. 12. 2000 w.

1408. Hardening Steel. A Knowledge of the Process Which It Undergoes a Great Aid in Tempering (Chiefly a practical discussion, but touches somewhat upon the theory of hardening and tempering). Bos Jour of Com-Sept. 14. 1400 w.

1422. Contraction vs. Strength of Cast Iron. Thomas D. West (The object of this paper is to prove that the same element that can cause any form or size of test bar to be unreliable as a record of strength, also destroys its value for recording the contraction of iron). Ir Tr Rev-Sept. 12. 2000 w.

1430. Ball Turning Device. Ill. C. K. (Device for performing this operation in a common engine lathe). Age of St-Sept. 14. 400 w.

1477. Tempering Scientifically. A. A. Simonds (Results of 18 months experiments aided by a thermo-electrical pyrometer. An important article). Am Mach-Sept. 19. 1000 w.

1478. Belts and Belt Lacings. Tecumseh Swift (An examination of the article "An Experimental Study of Belt-lacing," by Walter E. Flint. Analysis of results). Am Mach-Sept. 19. 1100 w.

1479. Some Reasons Why Bearings Heat. Peter H. Bullock (Personal observations and conclusions). Am Mach-Sept. 19. 800 w.

1575. An Experimental Study of Belt Lacing. Ill. Walter Flint (Results of practical experiments on eleven different forms of belt lacing. A valuable article). Am Mach–Sept. 5. 900 w.

1578. Grinding Reamers and Milling Machine Cutters. Tecumseh Swift (Practical details). Am Mach–Sept. 5. 900 w.

1579. Some Points About Experimental and Special Work (Conditions on Which W. D. Forbes & Co. take and turn out work). Am Mach–Sept. 5. 800 w.

1601. False Economy in Foundry Equipment. H. Hausen (Read at the Western Foundrymen's Asso. An eminently practical paper in which it is held that "economy" is a misnomer for many of the savings made in the foundry. Discussion). Ir Age–Sept. 26. 3500 w.

1668. The Art of Callipering—Hardening and Tempering of Steel (A practical treatment of these subjects). Bos Jour of Com–Sept 28. 700 w.

1756. Bicycle Tools. Ill. Hugh Dolnar (Proposes to give accurate information as to tools and methods in use in bicycle shops. The first number treats of rim-gluing tools and rim-shaping). Am Mach–Oct. 3. Serial. 1st part. 2500 w.

1757. Spirals on the Milling Machine.—Notching and Hobbing Worm Wheels. Ill. A. H. Cleaves (An explanation of the application of formulæ printed in tables accompanying milling machines for the benefit of ordinary workmen and foremen). Am Mach–Oct. 3. 1700 w.

1773. The Teeth of Mills. Ill. Winthrop Ingersoll (Takes the ground that the problem of cheap mill grinding has not yet been fully met by anything in common use, and generally discusses the subject of the construction of milling machines, milling cutters, arrangement of teeth, etc). Mach–Oct. 2700 w.

1774. On the Transmission of Power by Ropes. Ill. John H. Cooper (Presents, in a condensed form, a profusion of leading facts and data which have been obtained by experience with, and discussion of this method of power transmission) Mach–Oct. 2200 w.

1777. Machine Builders Records. Henry Hess (Presents a new plan for keeping simple records that do not require rewriting with every change of design). Mach–Oct. 1200 w.

1778. Strength and Proportions of Gear Wheels. Ill. J. L. Klindworth (Description of method for designing teeth, with formulæ derived from F. Reuleaux). Mach–Oct. 2000 w.

Steam Engineering.

1409. Getting Rid of Scale (Deals with methods of prevention as well as those for removing scale, and points out a danger in the contraction method of removal unless the latter be applied with great skill and care). Bos Jour Com Sept. 14. 1500 w.

1438. Piston Valves. Northeastern Railway of England. Ill. (Description also analyzes the cards taken from locomotives using these valves, with tables of the valve motions, including lead, opening, cut-off, release, angle of release, etc., for both forward and backward gear). Ry Rev–Sept. 14. 2000 w.

1577. Crank Shaft Stresses on the Central Valve Engine. W. H. Booth (Comparison between single and double acting engines). Am Mach–Sept. 5. 2700 w.

1604. The Design and Construction of Safety Valves for Steam Boilers. Ill. Edward W. Barber (Classifies and analyzes the action of the different types of safety valves; discusses proper and improper methods of fitting them to boilers, etc., favors the dead-weight type). Safety V–Sept. 15. 2700 w.

1605. A Method of Proportioning Cylinders for Compound Engines. E. C. Knapp (A method keeping in view that the load should be equally divided between the cylinders throughout the entire range of load, and that the range of expansion and temperature should be economical). Safety V–Sept. 15. 1100 w.

1606. Clearance in Steam Engine Cylinders (Editorial. Calls attention to the importance recently attached to clearance, and a general discussion of its effects). Safety V–Sept. 15. 1600 w.

1612. Vacuum; and How It Is Produced. Arthur Goodwin (Treats of the kind and degree of partial vacuum produced in condensation of steam, its measurement, and other practical and theoretical points connected with the subject). Mas St Fit–Sept. 1500 w.

*1657. Steam Locomotion for Passenger Traffic on Common Roads. Ill. William Fletcher (An exhaustive series of articles, well illustrated and with copious references, treating of steam locomotives intended for the conveyance of passengers and light goods at fairly high speeds, on common roads). Eng, Lond–Sept. 20. Serial. 1st part. 3000 w.

*1678. Summary of Twenty-one Steam Boiler Experiments. Bryan Donkin (A very able paper. The experiments made with vertical tubular, Lancashire, locomotive, water-tube, Cornish, elephant, cross tube fire engine and Cornish multitubular boilers, with tables of dimensions and data determined and results in fuel consumption, evaporation, etc., in tabulated form, and also graphically represented. Is a valuable contribution to the literature of steam engineering). Engng–Sept 20. 1800 w.

*1702. Boiler Furnaces: Their Construction and Renewal. Ill. A. V. Coster (A practical discussion of boiler furnaces considered as the most important factor in steam generation, and with a view to the attainment of greater durability). Ind & Ir–Sept. 20. 3000 w.

Miscellany.

1324. A Foundry Sketch—Low Priced Work. Ill. (Describes a variety of low-priced foundry work, turned out from western foundries, with practical remarks upon systems and processes whereby those results are reached. An instructive article). Am Mech–Sept. 12. 2300 w.

*1340. Coal Gas as a Locomotive Power (Editorial sustaining the view that compressed gas used in a manner analogous to that employed on tram cars at Dessau is more feasible for self-propelling road carriages than electricity). Jour Gas Lgt–Sept. 3. 1400 w.

1444. Gas as a Source of Power (A Comparison of its possibilities with electricity as a means of power transmission). Pro Age-Sept. 16. 800 w.

1456. Blast Furnace Gas.—Its Use as a Motive Power Practical and Economical (Experiments in England and France discussed. Mechanical difficulties). Tradesman-Sept. 15. 2200 w.

*1485. A New Departure in Dock Pumping. Ill. (Description of a Tangye gas-engine as applied to dock pumping). Eng, Lond-Sept. 13. 900 w.

*1512. Triple-Expansion Engine with Corliss Valve Gear (Illustrated description of a stationary engine built for a South African firm by Messrs. Fraser and Chalmers, of Chicago). Engng-Sept. 13. 1500 w.

1550. Some Difficulties in Manufacturing. Clarence E. Bement (Read before the Mich. Eng. Soc. Discusses power tranmission, shafts, and counter-shafts, forging, foundry work, making additions to plant, repairs, management of men, etc). Ir Age-Sept. 19. 3000 w.

1564. Kerosene Motors. J. H. Killey (Their method of action as applied to vehicles, &c). Can Eng-Sept. 1300 w.

1576. Molding Pump Plungers Without Anchors. Ill. J. Weyhenmeyer (The most approved method). Am Mach-Sept. 5. 1000 w.

1594. Electric Power Pumps for Water Works. John M. Goodell (A comparison of pumping by gas engines with pumping by electric power ; description of two electric pumping plants ; small, high service districts considered a promising field for the use of electricity for waterworks pumping). Eng News-Sept. 26. 2500 w.

1602. An Example of Cost Sheets for Foundries. A. Sorge, Jr. (Exemplification of blanks for cost sheets and system of preparing them, framed on a logical basis and designed to secure accuracy. Discussion). Ir Age-Sept. 26. 5000 w.

1603. Reduction and the Effect of Diameters on Bars in Rolls. William Hirst (Principles which should govern design of rolls for different sections ; knowledge of best form of passes essential. Rolls cannot be laid out from rules on account of the continually varying condition of the metal acted upon. A useful and instructive article). Ir Age-Sept. 26. 3500 w.

*1608. Coach Makers' Machinery. Ill. (Description of machinery and operations in modern carriage building, in the extensive works of Studebaker Bro's. Mfg. Co., South Bend, Ind). Mach, Lond-Sept. 15. 1000 w.

*1615. The DeKalb Electrical Pumping Plant. Ill. Daniel W. Mead (Full description with details ; tabulated results ; with lengthy discussion by members). Jour Asso Eng Soc-Aug. 9500 w.

1619. Compression in Locomotive Cylinders (Effect of compression on economy. Illustrated by three diagrams). R R Gaz-Sept. 27. 1400 w.

*1661. Locomotive Steam Crane. Ill. (A crane perched on a locomotive boiler). Eng, Lond-Sept. 20. 250 w.

*1679. Jointless Felloes (Describes and illustrates the processes of making steel bicycle rims at a great Birmingham establishment). Engng-Sept. 20. 2400 w.

1761. A Horseless Carriage of 1827. Ill. (In connection with the present effort toward constructing practicable self propelling vehicles for common roads, this article, describing one of the earliest attempts at producing such a vehicle, will be read with interest). Sci Am-Oct. 5. 1400 w.

*1768. An Example of Wheel Construction. E. S. Cobb (Describes and illustrates a fly-wheel for a 500 H. P. engine designed by E. S. Cobb, of San Francisco, in which all the strains are tensile). Am Eng & R R Jour-Oct. 600 w.

1776. Directing and Starting Engines. Ill. "Spike" (A practical, useful and instructive paper, especially for young mechanical engineers. Gives full and plain directions for this kind of work). Mach-Oct. 2500 w.

1779. Machine Shop Arithmetic. W. L. Cheney (A series of practical articles clearly explaining the portions of mathematics which will be useful to the men in the shop and engine room). Mach-Oct. 2200 w.

1802. A Gas Engine that is Expected to Revolutionize the World's Power (An interview with Mr. Geo. Westinghouse, Jr., on new inventions, especially in regard to his opinion of gas engines). Mfrs' Rec-Oct 4. 3000 w.

*1817. Rotary Bolting Machines. Ill. Kernal Wheatley (Historical and descriptive). Am Miller-Oct. 1. 1500 w.

*1819. Mill Machinery and Methods. J. F. Newby (A paper read at the Penn. Millers' State Asso. A retrospection and discussion of the prevailing method of gradual reduction by rollers, with remarks upon handling and storing wheat, bolting, and machinery and appliances used in modern milling). Am Miller-Oct. 1. 1600 w.

1827. How to Overhaul a Gas Engine. Ill. J. W. Seers (Practical and plain directions for the care of gas-engines, and their maintenance in good running order). Am Gas Lgt Jour-Oct. 7. 1600 w.

*1834. The Soho Foundry. Ill. (Description of a famous establishment. The first number gives a history of the works since the time of their ownership by Boulton and Watt, and describes some of the tools, with excellent line engravings). Eng, Lond-Sept. 27. Serial. 1st part. 3800 w.

1848. The Strength of Metals at High Temperatures (Investigations of Le Chatelier. Important as relating to safety of copper and its alloys in engine and boiler mechanism under modern high steam pressures). Ry Rev-Oct. 5. 900 w.

1879. High Silica Fire Brick. Charles Terry (Stating the impossibility of producing a single brand of fire brick which shall give superior results in every class of furnace work. The most reliable index of their applicability is found in their chemical composition). Ir Age-Oct. 10. 1300 w.

MINING & METALLURGY

Legislation Against Mining Stock Brokers.

In order to avert the possible evil effects of the practice of mining-stock brokers in dealing in shares on their own account, while buying and selling for others at the same time, the legislature of New Zealand is considering a bill containing a clause of which the following is the first paragraph:

" From and after the commencement of this act no sharebroker shall, on his own account, or on account of his wife or of any member of his family, or any clerk or servant in his employ, in any way, directly or indirectly, buy, sell, deal in, or become the holder of any shares or stock in any mining company registered or incorporated under the principal act or the companies act of 1882."

This remarkable clause has already passed the house, and will probably pass the upper chamber. *The Australian Mining Standard* (Aug. 24) thus comments upon it in an editorial : " It is an unfortunate thing that gambling should have associated itself so closely with mining. But there are certain features about the industry which lend themselves to speculation ; and, so long as humanity is human, and shares are available, the game of speculation will be played. It may be *infra dig.* for brokers themselves to follow the example of their clients, the public, and operate on shares ; just as it is unfortunate that the public should largely view mining as a medium for a gamble. And it may be that the practices of giving a fictitious value to property tend to mislead and destroy confidence. All mining countries are liable to ' booms,' the period when speculation is most rampant, and when legitimate industry is most handicapped. The liability, while it is to be deplored, will certainly not be removed by any such gross infringement of private rights as the legislature of New Zealand now seeks to impose. Brokers who job are simply members of the public, and if, for the betterment of their own fortunes, they apply the methods adopted by the public generally, however immoral, injurious, or objectionable those methods may be, they must not be specially censured; nor must their liberties be unfairly restricted in the manner proposed. It is bad enough to seek to deter the man himself; but to say that neither his wife, nor his sister, nor his cousin, nor his aunt, 'shall, directly or indirectly, buy, sell, or deal in, or become holder of any shares or stock' in mining companies, is the height of legislative absurdity." The editor concludes with the observation that " the evil they are grappling with may very well be left to work its own cure. Trouble may result from the operation in the meantime, but we are sure it would be insignificant compared with the disadvantages which must follow upon the insertion of the new clause in the Mining Companies Act Amendment Bill."

Use of Steel Girders in Mines.

Remote from the considerations of strength and life of steel, as compared with wood, for underground reinforcement, come those of availability and adaptability. In new camps timber is often plenty, but it requires very few years of continued mining to exhaust the neighboring supply. Fortunately the low price of structural steel makes it available as a competitor with timber for many uses—notably as a substitute for mine timbers. *The Colliery Guardian* (Sept. 20), in abstracting from a paper by Mr. E. Thompson read before the Federal Institute of Mining Engineers, says on this subject : " As an instance of the working conditions to be met with in a mine, it may be mentioned that the weight to be supported is not only unknown, but practically irresistible, and the strain is further complicated by pressures both from the top and the sides. Instead of being regular and uniform, the load is varied, and in cases increases with sudden and tremendous force. . . . It may be mentioned that, in the mine where Bessemer steel girders were placed here and there among the timber bars, the latter have been broken, while the girders remained uninjured. A bent girder, of course, may be reset. The sections of girders in general use in main roads are as follows:

Depth of Girder.	Width of Flange.	Thickness of Web.	Weight per foot.	Estimated safe dead load, distributed over 8 ft. span.	Length of bars recommended for given weight per foot.
in.	in.	in.	lbs.	tons.	feet.
5	4	⅜	16⅔	7	6 to 8
5	4	½	22	9	8 to 10
6	4½	½	24	12	10 to 14

"At the present time, estimating the girders at £5 per ton, these sections cost respectively 9d. 1s. and 1s. 1d. per ft. Comparing these prices with best larch timber, the cost of girders is very little in excess of timber, and, if the cost of cutting and trimming the timber be included, with an allowance for waste, steel girders will probably be found to cost less per foot, and in addition prove much stronger. . . . Girders compare favorably with timber, as they give an additional 4 or 5 in. in the height of a road; they possess greater durability where exposed to moist air, which, in some mines, destroys the timber in a few weeks; and they are equally suited to pit bottoms, main roads, and return ways. Girders intended for use in very wet places may be tarred at a slight cost. They can be drawn and reset many times, where timber would not be worth the cost of recovery. In the event of fire, timber is not only destroyed, but helps to spread its effects, while girders remain intact, and the road in good order. The blocking of the roads caused by floating timber is also avoided, should the mine be flooded with water." The article treats of fastening devices, etc., and ends with the discussion of the paper, bringing out corroborative statements, as well as the fact that steel and iron posts and props were successfully employed in some coal collieries.

The Iron Industry in Germany and England.

AFTER considerable investigation of the condition of the German iron works, the British Iron Trade Association have prepared a report, advance items of which have appeared in the London *Times*, according to the English correspondent of the *American Manufacturer* (Sept. 20). The tenor of the report is liable to disturb the self-complacent manner in which an Englishman regards everything British. The deputation which visited the continental works "emphasize the superior character of the machinery and labor-saving appliances which are to be found at some of the Belgian and German works, showing a remarkable advance in those countries compared with even the best appointed works in England. The deputation are not now surprised at the rapid growth of the Belgian and German iron and steel exports."

There is not as much difference in wages as has been supposed, those of Belgium being even slightly higher than in England, showing that the growing German trade is not due to low wages.

"We know that ever since the introduction of the basic process the Germans have been quick to adopt the best machinery for steel making. While English manufacturers have paused—over-awed by the heavy cost which would be involved by laying down new plant,—the Germans have steadily gone in for steel making, and so have become formidable competitors in the steel trade. Moreover, the foreigners, who have closely studied the English systems of iron and steel manufacture, have at every point introduced some new feature of more or less value, directly tending to economize the manufacture. Further, in the matter of technical education, the Germans are ahead of us. At Berlin they built an enormous technical school out of a portion of the Franco-German war indemnity. That school has sent out chemists all over the civilized world, and some of them are to be found in the metallurgical laboratories at English works." However, this is not the only cause. "Many years ago Professor Willis said: 'Englishmen make the best machines, whilst Germans describe them.' In other words, if you then wanted a good machine, you must buy it in England, and, if you wanted a description of it, you could read it only in German. This technical and scientific literature to which Prof. Willis referred has undoubtedly been the foundation on which Germany has built her manufacturing position as on a solid rock. By its means, and assisted by a thorough educational system, and supplemented by specific technical instruction such as we have as yet but imperfectly adopted, owners of works in Germany, as well as their foremen and workmen, commence their duties in the spirit of students rather than as prejudiced inheritors of old methods and ideas."

Though this is rather an extreme view of the case, the fact remains that the foreign English market is being gradually displaced by the continental products, especially such as are used in engineering work.

Comparative Effect of Explosives.

An important feature of all modern investigation is the tendency to reduce all results to figures and to keep fixed records in such a way that results may be compared. This we see strikingly brought out in a series of experiments to determine the effect of certain explosives in deforming a lead cylinder, by Bergassessor Wickhaus. These results were communicated to *Glückauf* and republished in *The Colliery Guardian* (Sept. 20). The experiments were made on the assumption that the extension of the cavity in the lead block measured the explosive force.

The nearly cylindrical lead blocks used in the schalke (Westphalia) tests were prepared as shown by Fig. 1, having a height of 24 cm. and a diameter of 14 cm., a slightly conical form having been adopted for facilitating the casting of the block. The cylindrical hole 25 mm. in diameter and 145 mm. in depth is increased above for receiving the cover to a diameter of 60 mm. The lead block was wedged tightly into a strong wrought-iron frame, and the volume of the central cavity measured before and after explosion by water from graduated tubes. Ten-gram charges were employed, exploded by 2-gram mercury fulminate detonators. "The analysis of the explosives tested are given as follows by various authorities. According to the president of the Berlin Mining Laboratory, gelatine-dynamite contains 64.5 per cent. of gelatinized nitro-glycerine, 26 per cent. of nitrate of potash, and 9.5 per cent. of ground wood, while the carbonite contained 25 per cent. of trinitro-glycerine. Firedamp dynamite contains 52.9 per cent. of trinitro-glycerine, 32.7 per cent. Epsom salts, and 14.4 per cent. fossil meal. Progressite: 92 per cent. ammonia nitrate, 6 per cent of aniline hydrochlorate, and 2 per cent. of ammonia sulphate. Westphalite consists of 94 per cent. of ammonia nitrate, 5.4 per cent of resin, 0.4 per cent. of ammonia sulphate, and 0.1 per cent. of each of sal-ammoniac and smut. Dahmenite: 93.3 per cent. of ammonia nitrate, 4.8 per cent. naphthaline, 1.6 per cent. of potash chlorid, 0.1 per cent. of sal-ammoniac, and 0.2 per cent of ammonia sulphate. Roburite: 17.8 per cent. of dinitro-benzol, 79.2 per cent. ammonia nitrate, 0.3 per cent. sal-ammoniac and ammonia sulphate, remainder moisture." It was found that the more uniform explosives gave the highest values.

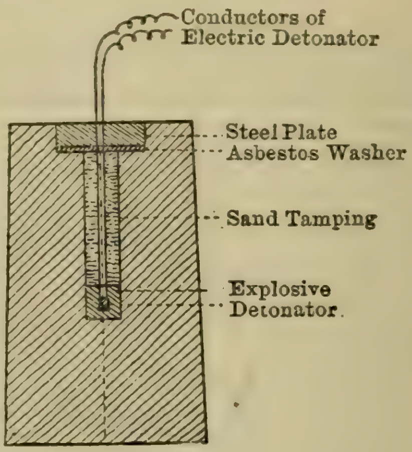


FIG. 1.

"For showing the nature of their action, Fig. 2 gives a representation of the widening out of the cavity in the lead block effected by ten-gram charges of the explosives. The lines made by roburite, dahmenite, and progressite, being very similar, were left out.

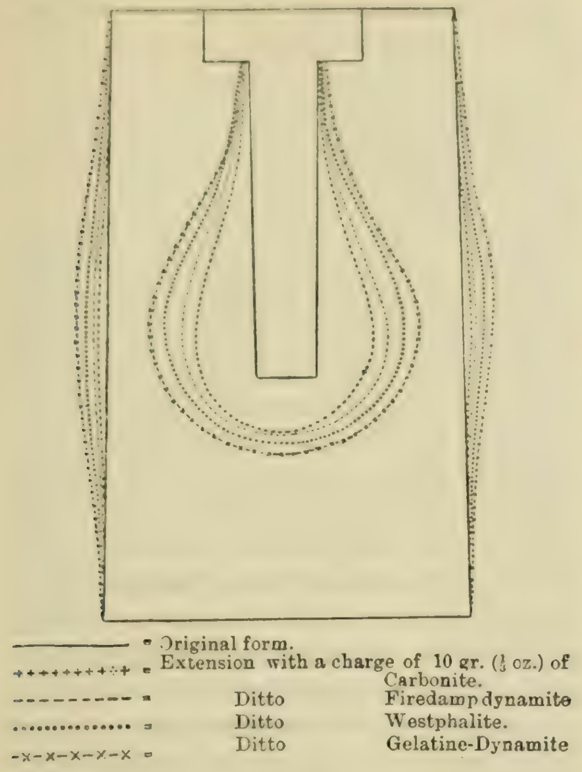

——— = Original form.
+++++++++ = Extension with a charge of 10 gr. (⅓ oz.) of Carbonite.
- - - - - - - - = Ditto Firedamp dynamite
.... = Ditto Westphalite.
-x-x-x-x-x = Ditto Gelatine-Dynamite

FIG. 2.

"As the resistance to distension becomes less, the less the thickness of the leaden sides. Experiments to determine the quantity and volume necessary to produce the same effect were performed. The table below gives in a summary the results of these experiments, showing the relative values of these high explosives."

Explosive.	A.	B.	C.	D.
Gelatine-dynamite	10	1.000	1.00	1.000
Carbonite	21½	0.465	0.73	0.339
Firedamp dynamite	17	0.588	0.95	0.559
Progressite	17	0.588	0.60	0.353
Westphalite	14	0.714	0.55	0.393
Dahmenite A	13	0.770	0.53	0.408
Roburite	12	0.883	0.61	0.509

A.—Quantity (in grams) of explosive required to produce the same increase in space.

B.—Comparative explosive action calculated from A.

C.—Comparative weights of the same bulk.

D.—Explosive power of the same bulk.

The safety explosives—firedamp dynamite and roburite—are used almost exclusively in 23-mm. or] 25-mm. cartridges, while the lower explosives are generally put up in 30-mm. to 40-mm. cartridges. The charge is thus distributed over a greater area, avoiding the shattering effect, which is specially undesirable in coal mining or blasting stone. The article, as originally contributed, contains full details of the experiments.

The Place of Tungsten in the Industries.

UNDER the above title Mr. F. Cramer contributes some facts of commercial interest in *The Iron Age* (Sept. 12). The properties which render tungsten of importance are its hardness and the property of imparting hardness to its alloys, and its high specific gravity. The largest quantity is used in alloying with steel, to which it imparts such natural hardness that no tempering is required when used for machine tools,—*i. e.*, it is "self-hardening." Speaking of the uses to which tungsten is put, the writer says: "The hardness of tungsten recommends it directly for use in cutting tools. In these it is the chief aim to have a hard resisting tool, with a certain degree of toughness to withstand shocks. This resistance it receives from an addition of manganese, and perhaps also of nickel. This kind of steel is not suitable for extremely hard work exposed to severe shocks, nor is any other steel. But in the manufacture of knives, surgical apparatus, and especially razors, tungsten could be employed to a great advantage. It is well to remember in this connection that an addition of carbon gives the steel a certain amount of hardness; so does tungsten. . . . . Whether tempered or untempered, the addition of tungsten to razor steel must result in a decided gain over carbon steel." For use in armor plates and projectiles "the objection has been raised that tungsten steel is too brittle for the purpose. This objection would be a very strong one, if the whole shell or plate were made of the same material throughout, although an addition of manganese could be employed to counteract this effect of tungsten. But, just as Harvey plates are given a coating of carburized and tempered steel so in tungsten plates only the surface should contain tungsten. This is effected in a recent patent by Chase & Gouth, where molten steel is poured on a bed or mould covered with powdered tungsten, when the fluid steel melts and alloys with the tungsten." The author inclines to the belief that small quantities of tungsten added to structural steel will increase the elastic limit. "Howe's book on the metallurgy of steel contains the result of a number of experiments on tungsten steel, as furnished by Holtzer at the Paris exposition of 1887, and we take from them the following figures:

STEEL.	Tensile Strength.	Elastic Limit.	Elongation.
Naturally hard....	77,941	41,672	23.5
" " ...	93,071	47.514	17.0

. . . . A slight gain in the elastic limit over the steels now in use would amount to such a large saving in our modern gigantic structures that the game surely seems worth the candle." Tungsten could be added to aluminum to make it harder, in preference to copper, which has a tendency toward galvanic action in waters containing alkalies or acids.

"In all probability the hardness and resistance against abrasion of gold, silver, platinum, copper, etc., could be increased considerably, and silver and gold coins would make a splendid field for such tungsten alloys."

Among the suggested uses are steel springs, pianoforte wire, an abrasive in place of emery, rifle and other bullets, steel to increase magnetism, alloys and bronzes, and various chemical forms. The red oxid is harder than the metal, and may find its use as an abrasive. "The statement of Howe that 'steel may contain much larger proportions of tungsten than of carbon without losing its property of being forged,' seems to us perfectly correct. In any one of the twelve to fifteen mills in the United States where tungsten steel is made, one may any day see the product, generally containing from 5 to 6 per cent. of tungsten, forged, that being, in fact, the only way to reduce the ingots to bars."

Three Colorado Mine Tunnels.

ABOUT the forks of Clear creek cluster some of the richest gold mines in Colorado. The Colorado gold deposits are of unknown extent, and of such a reliable character that permanent works may be erected with the assurance that there is plenty of ore to work on. It is strange that the deposits have been almost ignored by English and continental capital in its craze over South African mines of less merit. A correspondent to *The Mining Journal* (Sept. 14) writes concerning the Clear creek tunnel enterprises: "These mines are operated at very considerable expense for pumping water, hoisting ore, and hauling such ore down to the railway tracks; and, in consequence of such excessive cost, the working of some of them has been temporarily abandoned, as there is no margin of profit left, notwithstanding the existence of large bodies of ore. In practically every case the deepest workings revealed the continuance of ore in undiminished quantity, and of much the same quality." To drain this district and to take out the ore by the assistance of gravity, three tunnel enterprises are in operation.

"The first of these is the Newhouse tunnel [described in THE ENGINEERING MAGAZINE for October.—ED.], being constructed by British capital. It enters the mountain a short distance below Idaho Springs. Its total length will be nearly 4 miles, running under Seaton mountain, Russell gulch, and Quartz hill, and will take several years to complete. It is expected to cut over three hundred known veins, exclusive of 'blind' veins,—that is, veins not known on the surface, and which will belong to the tunnel. It is 12 ft. wide by 12 ft. high, is already in ½ mile, and is being rapidly pushed by means of double shifts of men and Leyner air drills operrated by powerful compressors.

"The second enterprise, the United States tunnel, is as yet only at its commencement, and, it is said, will be constructed by French and Dutch capital. It starts in about ½ mile above Idaho Springs, about 1½ miles west of Newhouse tunnel. It is proposed to run it about 3½ miles under Belle Vue mountain, the head of Virginia cañon, Russell gulch, Quartz hill, and Gunnell hill, but as yet it is in but between 200 and 300 ft. by hand work, and air compressors have not, so far, been put up for the operation of air-drills.

"The third enterprise is the Philadelphia tunnel being constructed by Philadelphia capitalists, primarily to tap their own mining properties. It starts on Fall river (a tributary of Clear creek) about 4 miles above Idaho Springs. It is in about 2700 ft., and another 1000 ft. has been contracted for, 3000 ft. being required to crosscut their own property. It will be further continued to a total length of 2½ miles to tap the Nevadaville gold belt at its terminus, being about 1000 ft. below the surface. It is about 8 ft. by 9 ft. in size, and is expected to cost altogether about £100,000.

"Briefly stated, these three tunnels will undermine, at an average depth of from 1000 to 2000 ft., a mountain chain or group 4 miles in diameter, traversed by an extraordinary number of parallel true-fissure gold- and silver-bearing veins, the richness of many of which has been satisfactorily proved, while the existence and richness of the others is fairly assumed. . . . It is self-evident that the next few years will see wonderful mining development in that special locality, and a very marked increase in the gold product of Gilpin and Clear creek counties (both of them very small counties), which, under present conditions, is about £1,000,000 sterling per annum."

Open-Pit Mining.

MR. F. W. DENTON read a paper before the Lake Superior Mining Institute with the above title, having special reference to the Mesabi range. As these Minnesota iron ore deposits are practically closing all the small mines of our northern States, it becomes a matter of interest to know how they are able to produce ore thus economically. The author states that "thus far two general methods of open-pit work have been adopted: one is to strip a comparatively large area, and then, after having loosened the ore by blasting, to remove it by means of steam shovels, railway cars, and locomotives. The other method is known as the 'milling' system, or better, perhaps, as the 'stripping' milling system, and as a combination of surface and underground workings. The ore is stripped of its surface covering, and then blasted into raises which connect with drifts established 50 or 60 ft. below the top of the ore. From the raises the ore is loaded into cars, trammed to a shaft, and hoisted. . . . The steam shovel, from a mechanical standpoint, is a very uneconomical machine, and the cost of repairs is high.

"In the milling system the work grows in depth, and, after a given amount of stripping has been done, all of the ore uncovered may be removed before further stripping is necessary. When a block of ore has been mined, the pit thus made may be used as a place of deposit for the next stripping. It ought to be possible to utilize this advantage to materially reduce the cost of subsequent stripping, for the haul would be short, and by systematic methods the bottom of the stripping could be dropped into the bottom of the pit, and gravity would thus be made to assist throughout the work. . . . The one disadvantage of the milling system is the necessity of sinking shafts and putting in drifts and raises. The cost of this work per ton of ore obtained is, however, low, and, when we remember that in many of the deposits proper drainage can only be obtained by a shaft and by drifts in the bottom of the ore, this disadvantage is of little importance." After enumerating the advantages of open-pit working over underground methods, the writer sums up the disadvantages as being the necessity of providing a place for excavated material, the labor wasted in handling unsalable ore or glacial drift, and the increase in cost of working with the increase in depth. In comparing the cost of the two systems, he says that "the results show a difference of 21½ cents per ton of 2240 lbs. in favor of the milling system," and, after calculating the cost of the stripping he concludes with Mr. Larsson that, "where the volume of ore to be uncovered is equal to, or greater than, the volume of surface to be removed, it will pay to strip."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Technical Journals—See Introductory.

Metallurgy.

1326. Production of Aluminum (A brief history of the industry with some general results of experiments with iron and steel, and application to marine uses). Am Mech–Sept. 12. 1500 w.

1333. The Place of Tungsten in the Industries. F. Cremer (An excellent article giving the uses, properties, and adaptations). Ir Age–Sept. 12. 5500 w.

1334. Importation Probabilities (Editorial. Excess of demand over supply of manufactured iron with statistics from 1876 showing the tendency). Ir Age–Sept. 12. 700 w.

†1338. Recent Progress in Siemens-Martin Furnace Construction. Ch. Walrond (Notes on some of the improvements over the old furnace which increases the production and decreases the cost of the furnace repairs). Ind & East Eng–Aug. 10. 1800 w.

1355. History Repeating Itself in the Iron Trade (A detailed editorial on the condition of the iron industries). Eng News–Sept. 12. 1700 w.

1361. Steel-Making Experiments.—Results at Birmingham Indicating What Is Possible.—Brown Ores Suggested as Necessary. H. S. Fleming (Enumeration of companies making steel, with difficulties encountered, especially with southern ores and pig). Mfrs Rec–Sept. 13. 2000 w.

1407. Coke Making in the South of Russia. (Method of manufacture, with cost). Am Mfr & Ir Wld–Sept. 13. 600 w.

1420. Tina Amalgamation. Pazos y Sacio (The use of a copper in preference to an iron pan. A terse description of the South American methods of amalgamation). Eng & Min Jour–Sept. 14. 1800 w.

*1474. The Basic Bessemer Process (Editorial comment upon the production of basic steel in Germany). Ir & Coal Tr Rev–Sept. 13. 900 w.

1480. Abstract of Report of Committee on Standard Tests and Methods of Testing Materials. Gus C. Henning (Relation of silicon, sulphur, phosphorus, etc. on the physical and casting properties of cast iron. Diagrams of curves representing the expansion on cooling with recording apparatus). Am Mech–Sept. 19. 2100 w.

*1484. The Steel Plant at the Earl of Dudley's Round Oak Works. Ill. (Description with three half tone views of interior of a prominent English steel works). Eng, Lond–Sept. 13. 1500 w.

1495. Nickel Steel (Editorial comment on a paper read before the Am. Inst. of Min Eng. Effect of corrosion and use of nickel nails on steel sheathing). R R Gaz–Sept. 20. 700 w.

1521. English Iron Works. Correspondence and editorial (Condition of English iron industry in comparison with that of Belgium and Germany. Comments on facts brought out by a visit of the British Iron Trade Association). Am Mfr & Ir Wld—Sept. 20. 2000 w.

1567. Smelting Refractory Ores in the Electric Furnace. George D. Burton (Remarkable success has been achieved). Elec Eng–Sept. 25. 1000 w.

*1589. A Competitive Trial of Flue-Heated Coke-Ovens. A. Hussener (Tests of ovens with vertical heating flues and air regenerators, with ovens with horizontal flues). Ir & St Tr Jour–Sept. 14. 600 w.

*1590. Influence of Heat on the Tenacity of Manganese Bronze. M. Rudeloff (The limits of admixture and conditions influencing its application to machine parts). Ir & St Tr Jour–Sept. 14. 300 w.

1592. Production of Aluminum (A condensed review of the growth of the industry). Min Ind & Rev–Sept. 19. 1300 w.

1632. Concerning Pyrometers. Ill. (An electric pyrometer claimed to accurately register all temperatures, with preliminary tests). Am Mfr & Ir Wld–Sept. 27. 1200 w.

†1694. Electro-Metallurgy, as Applied to Silver Refining and Incidentally to Other Metals. George Faunce (A brief historical sketch followed by the principles involved and a brief description of some of the processes used). Jour Fr Inst–Oct. 7000 w.

*1700. Continental Iron and Steel Manufacture (Report of the deputation of the British Iron Trades Asso. on the iron industry of Germany and Belgium. An interesting comparison). Ind & Ir–Sept. 20. 1600 w.

1742. The Bee Hive Coke Oven with Recovery of By-Products. Ill. (Description of plant as employed in England). Ir Age–Oct. 3. 1200 w.

1743. Recarburation of Steel in the Basic Converter by Means of Calcium Carbide. A. J. Rossi (Referring to the production of acetylene from Ca C 2, and also experiments in Germany on carburizing steel by this carbide). Ir Age–Oct. 2. 800 w.

*1745. Linings for Thomas Converters (Method of preparation of lime or dolomite lining of basic Bessemer converters. From the Swedish paper *Jeru Kont Annaler*). Ir & St Tr Jour–Sept. 21. 1700 w.

1808. Notes on Modern Steel Works Machinery. James Riley (Abstract of a paper read before the Inst. of Mech. Eng., Glasgow. Numerous examples of the various mill machines in use, with a description of their main features). Can Min Rev–Sept. 5000 w.

Mining.

1308. The Distribution of Power in Collieries. Ill. Llewelyn B. Atkinson (Favoring the generation of the entire power in one engine or pair of engines). Eng Mag–Nov. 3300 w.

1332. Flooded Mines at Black Hawk (Editorial. A disaster in a Colorado mine in which 14 lives were lost, caused by the water flooding the lower levels of the Fisk mine, breaking through into adjoining workings). Min Ind & Rev–Sept. 5. 1200 w.

†1337. Baragunda Copper Mine. Robert Oates (Brief description of an India copper mine. The reopening of ancient workings). Ind & East Eng–Aug. 10. 1000 w.

1369 South African Gold Fields (An editorial giving interesting statistics of this important gold producing region). Min & Sci Pr–Sept. 7. 1500 w.

*1379. Avondale Marble Company and Its Derrick Ill. (Description of a very large derrick, covering a circle of 160 ft. in diameter, and lifting a weight of 100 tons). Stone–Sept. 2000 w.

*1380. Explosives. Wolcott C. Foster (An extended classification with valuable information on gunpowders and nitro-glycerine compositions). Stone–Sept. 2000 w.

†1398. The Iron Ranges of Minnesota. Map. Horace V. Winchell (Short descriptions of the various mines operated, with table of the Minnesota production since 1894). Pro of Lake Sup Min Inst–March. 5500 w.

†1399. Address by the President. J. Parke Channing (An original paper on the accidents to miners in the Lake Superior mines, with tabulated summary). Pro of Lake Sup Min Inst–March. 5000 w.

†1400. Distribution of Phosphorus and System of Sampling at the Pewabic Mine, Iron Mountain, Mich. E. F. Brown (A short paper showing where the highest percentage of phosphorus occurs in the ore body). Pro of Lake Sup Min Inst–March. 2500 w.

†1401. Efficiencies of Some Pumping Plants on the Menominee Range. Per Larsson (Comparison of the duty of some of the Cornish and Worthington pumps actually used, with cost sheets, and discussion). Pro Lake Sup Min Inst–March. 1900 w.

†1402. The New Pumping Plant at the Sterling Iron and Zinc Co., New Jersey. J. Parke Channing (Short description, with extracts from report of a duty test furnished by J. A. Van Mater). Pro Lake Sup Min Inst–March. 1300 w.

†1403. The Hoisting Plant of the Lake Mine. Ill. J. M. Vickers (Used by Cleveland Iron Co. at Ishpeming, Mich. Description). Pro Lake Sup Min Inst–March. 1600 w.

†1404. The Relation of the Vein at the Central Mine, Keweenaw Point, to the Kearsarge Conglomerate. L. I. Hubbard (General description of veins with four inset plates). Pro Lake Sup Min Inst–March. 3000 w.

†1405. Open-Pit Mining, with Special Reference to the Mesabi Range. F. W. Denton (Discussion of the various methods adopted, with their relative advantages). Pro Lake Sup Min Inst–March. 3300 w.

1418. A Central Station in Mining Work. Timothy W. Sprague (Descriptive of a central station for electrical power at coal mines on the Youghiogheny River, with map and section). Eng & Min Jour–Sept. 14. 2000 w.

*1424. The Douchy Colliery, Nord, France (Brief description of mines and methods of working. Output in 1894 was 341,677 tons of coal. Employees share profits). Col Guard–Sept. 6. 1200 w.

*1425. Use of Crucible Steel Wire Ropes in Mines (Mine hoisting. Description of rope with tests of the steel wire. The cost of rope per ton of ore hoisted per 1000 m. depth, was about 4 fr. Recommends small ropes in preference to large flat ropes). Col Guard–Sept. 6. 700 w.

1458. Kootenay Mining and Smelting Co. Limited. Ill. (Description of mine and smelter located at Pilot Bay, B. C.) West Min Wld–Sept. 14. 900 w.

1459. Some Calaveras Mines. E. H. Schaeffle (A general account of several California mines). Min & Sci Pr–Sept. 14. 2000 w.

*1483. Improved Steel Frame Stamp Battery for Wet Crushing (Description with engraving showing two double 5-stamp batteries supplied to a South African company). Eng, Lond–Sept. 13. 650 w.

1502. A Sand Filter for Chlorination Barrels. Ill. John E. Rothwell (Description). Eng & Min Jour–Sept. 21. 800 w.

1503. The Siemens and Halske Electric Rock Drills. Ill. W. Meissner (Description of a rotary and a percussion rock drill). Eng & Min Jour–Sept. 21. 3700 w.

*1504. On the Valuation of Mining Properties. F. J. Spence (An interesting article giving a number of practical considerations). Aust Min Stand–Aug. 17. 1700 w.

*1506. Progress of Ore Treatment on the Rand (Description of methods employed). Aust Min Stand–Aug. 17. 1800 w.

*1518. Three Tunnel Enterprises. Thomas Tonge (Colorado gold mines. These tunnels will drain a group of mines four miles in diameter). Min Jour–Sept. 14. 1200 w.

*1519. British Guiana's Gold Mining Industry (Editorial comment upon an official report, giving production statistics). Min Jour–Sept. 14. 1300 w.

1520. New Electric Power Portable Mine Drill. Ill. (A single post, universally mounted, friction screw feed, extensible, light, electric, one man, coal mine drill). Am Mfr & Ir Wld–Sept. 20. 800 w.

1538. Electricity in Gold Dredging. Ill. Ralph L. Montagu (A description of the electrical plant, with brief history of the old mining camp). Elec Wld–Sept. 21. 2200 w.

*1588. Winding Ropes in Deep Belgian Collieries (The use of a ten strand aloe flat rope under a working strain of 90 to 110 kilograms per sq. c. m.; also crucible steel eight four-stranded parallel wire-ropes). Ir & St Tr Jour–Sept. 14. 500 w.

*1591. Chrome Iron Ore Mining in Asia Minor. W. F. Wilkinson (Description of occurrence with statistics of production). Ir & St Tr Jour–Sept. 14. 1800 w.

1607. A Modern California 20-Stamp Mill. Ill. (Description of plant with a stamp capacity of about 4 tons per stamp per 24 hours). Min & Sci Pr–Sept. 21. 450 w.

*1609. Machinery in South Africa.—Progress at the Gold-fields up to Date (Description of the machinery equipment of some of the gold mines). Mach, Lond–Sept. 15. 3700 w.

1631. Calcination of Spanish Ore (Description of method, kilns used and advantages in roasting the carbonate ores of Vizcaya). Am Mfr & Ir Wld–Sept. 27. 1400 w.

*1664. The Drainage of the South Staffordshire Mines (Removing the water from pounds which flooded the mines. Proposed methods). Ir & Coal Tr Rev–Sept. 20. 3300 w.

*1665. A Visit to the Gold Fields on the Hauraki Peninsula, N. Z. (Description of the various mines visited). Min Jour–Sept. 21. 3700 w.

*1667. Production of Gold, Platinum and Silver in Russia (Valuable mineral statistics). Jour Soc of Arts–Sept. 2. 450 w.

*1685. Experiments for Ascertaining the Comparative Effect of Explosives. Ill. (Details of experiments with results from eight high explosives). Col Guard–Sept. 20. 1800 w.

*1686. Bonneted Safety Lamps. James Ashworth (Article containing report of the Royal Commission. Results of observation and experiment). Col Guard–Sept. 20. 2800 w.

*1687. The Use of Steel Girders in Mines. E. Thompson (Abstract of paper read before the Fed. Inst. of Min. Eng. Showing advantage over timber). Col Guard–Sept. 20. 1600 w.

*1689. Meteorology and Mining. Abstract of paper by Joseph Thompson (Effect of atmospheric conditions in mine explosions). Col Guard–Sept 20. 2000 w.

*1690. Power Absorbed by Friction of the Shafts at the Supports—Co-efficients of Friction—Electrical Considerations. S. Hanappe (Experiments made at the School of Mines in Hainaut. Translated from the French). Col Guard–Sept. 20. Serial. 1st part. 1800 w.

*1691. Recovery of the Karwin Colliery. J. Kohout and J. Pilor (Method of advancing upon the demolished workings and the precautions adopted against the results of the explosion and fire). Col Guard–Sept. 20. 2800 w.

*1722. Legislation Against Brokers (Editorial comment on a proposed clause to the Mining Bill before the New Zealand legislature, preventing the stock broker from dealing in shares for himself). Aust Min Stand–Aug. 24. 800 w.

*1723. How Gold Occurs in Nature. W. Nichols (An elementary general lecture delivered at Chicago). Aust Min Stand–Aug. 24. 1800 w.

*1737. Certain Dissimilar Occurrences of Gold-bearing Quartz. T. A. Rickard (A valuble paper by the Colorado State Geologist, illustrated by sections of known deposits in the several gold regions of the world). Aust Min Stand-Aug. 31. Serial. 1st part. 3500 w.

*1770. Some Notes on Brown Hematites. John S. Kennedy (A general paper giving production, composition, methods of prospecting and testing, with improvements in mining). Tradesman–Oct. 1. 2500 w.

1771. Accidents in Coal Mines (Roof-falls, shown to be the principal cause of fatal accidents, with suggestions for prevention). Tradesman–Oct. 900 w.

1772. Alcatraz Asphalt. Ill. (Method of working the deposits of the Alcatraz Asphalt Co. in Santa Barbara Co., Cal). Min & Sci Pr–Sept. 28. 900 w.

1805. Gold Mining in Nova Scotia. F. H. Mason (Showing the tendency of later practice, the reasons for decreased output, and the productions of the various districts during 1894). Can Min Rev–Sept. 2500 w.

1825. The Hartville Iron Ore Deposits in Wyoming. E. P. Snow (A red hematite iron ore belt having an area of 25 to 30 sq. miles, 8 miles from the railroad). Eng & Min Jour–Oct. 5. 1300 w.

1829. The Proportion of Inflammable Gas Necessary to Produce a Mine Explosion (Experiments with mixtures of the various mine gases with air, to determine the proportion of air necessary for explosion). Am Gas Lgt Jour–Oct. 7. 800 w.

*1874. Prospecting for Placer Gold. Ill. Arthur Lakes (Progress on the Roscoe Placer scheme at Clear Creek, Col. A description of the 10×6½ ft. flume and 48-in. Allen wooden stave pipe, with 9 sketches). Col Eng–Oct. Serial. 1st part. 1400 w.

*1875. The Ore Deposits of Cripple Creek. Francis T. Freeland (The geology, character and extent of this famous Colorado mining region briefly treated). Col Eng–Oct. 1600 w.

*1876. Cableways at Coal Strippings. Ill. (The suspended cableway in use for "stripping" the coal seam at the Coleraine Colliery, Beaver Meadow, Pa.) Col Eng-Oct. 500 w.

*1877. A Flume Conveyor—Coal for Coke Ovens Conveyed 8400 Feet by Water. B. L. Lloyd (Description of the Montana Coal and Coke Co.'s method of reducing the cost of handling coal, by means of an 8×8 ft. wooden flume 8400 ft. long to the coke ovens). Col Eng–Oct. 3000 w.

*1878. The Drainage of Flooded Mines. Baird Halberstadt (The self-dumping water tanks used at Lake Fridler Colliery in removing a large quantity of water. These tanks pour out at the top and are made of old boilers). Col Eng–Oct. 700 w.

1883. The Northeastern Coal Field of Illinois). Description of the mines at Gardner, Braceville and Clarke City. Geological phases; new machinery; the miners). Sci Am Sup–Oct. 12. 3000 w.

Miscellany.

1312. A Surface Copper Mine. Ill. (A description of Ledford's Copper Precipitating Plant, the largest in America. Produces 100 tons copper per month from the Anaconda and St. Lawrence mine water in Colo). W Min Wld–Sept. 7. 800 w.

1368. Taxation of Minerals in Mexico (Discussion of a 5% tax laid on gold and silver products in Mexico). Min & Sci Pr-Sept. 7. 800 w.

1416. United States Mineral Production and Prospects (Table giving the quantity and value of the various mineral and metallic substances produced in the U. S. during the years 1893 and 94). Eng & Min Jour-Sept. 14. 500 w.

1417. Mineral Production of New South Wales (Short abstract of the report of the Department of Mines and Agriculture. Table of production of various minerals during 1893 and 1894). Eng & Min Jour-Sept. 14. 400 w.

*1452. The British Iron Trade Deputation to the Continent (Comments on criticisms of the methods employed by British iron workers in gaining admission to German Works). Editorial. Engng-Sept. 6. 1700 w.

*1454. New Iron Works in the Ural (A mill taking the iron of four charcoal blast furnaces. Manufacture of railroad rails). Engng-Sept. 6. 700 w.

*1473. The British Association. Douglas Galton (Extracts from Presidential address before the British Asso. Comments upon progress during the past 60 years). Ir & Coal Tr Rev-Sept. 13. 4000 w.

1489. Petroleum in Peru. H. Polakowsky (A general description of these old oil wells). Sci Am Sup-Sept. 21. 700 w.

*1505. The Bromo-Cyanide and Bromo-Hypochlorate Processes. C. A. Mulholland (Results of experiments on the replacing of oxygen by bromine). Aust Min Stand-Aug. 17. 1400 w.

*1513. The Geology and Useful Minerals of the French Congo. Maurice Barrat (Abstract of an article in the *Annales des Mines*, giving (1) the geological formations, (2) the mineral deposits, and (3) conclusions). Col Guard-Sept. 13. 2500 w.

*1514. Coal in South-Eastern England. W. Whitaker (Address of President of the Geological Section of the British Asso. A general discussion on the occurrence of coal in this region). Col Guard-Sept. 13. 2600 w.

*1515. Present Position and Prospects of the Coal Industry. W. W. Millington (Abstract of an address by the President of the National Asso. of Colliery Managers, giving statistics and commercial conditions). Col Guard-Sept. 13. 750 w.

*1516. The Mining Congress in Hanover (Proceedings of the Congress of German Mining Engineers, who meet every three years). Col Guard-Sept. 13. Serial. 1st part. 1200 w.

*1517. Experiments on Centrifugal Fans. Bryan Donkin (Paper read before the English Inst. of Civ. Eng. Deductions from the results of practical tests. Nine cuts. Three tables. An excellent paper). Col Guard-Sept. 13. 5400 w.

1586. Minerals found in Western Carolina. Henry C. Demming (A list of the minerals with names of discoverer and person making the determination). Mfrs' Rec-Sept. 27. 700 w.

1596. As Seen by an Engineer (Account of a trip through the works at Trenton, N. J., the blast furnaces of the Lehigh Valley, the Bethlehem Iron Co., with a kindly reference to Mr. John Fritz, the eminent works engineer). Eng News-Sept. 26. 2800 w.

1633. Deep Water Way and Steel Making. Arthur J. Maxham (Read before the Deep Waterways convention. Shows the effect of transportation facilities on the local iron industries). Ir Tr Rev-Sept. 26. 1900 w.

1662. The Georgia Mineral Exhibit at the Atlanta Exposition (Description of the occurrence of each mineral with valuable information relating to its commercial importance). Eng & Min Jour-Sept. 28. Serial. 1st part. 4500 w.

*1688. The Origin of Petroleum. R. Nelson Boyd (A comprehensive treatise embracing theories of formation). Col Guard-Sept. 20. 2500 w.

*1738. Reasonable Geology. Frederick Danvers Power (A general article showing the popular conception of things geological and of ores with the methods of reasoning in geology). Aust Min Stand-Aug. 31. Serial. 1st part. 2600 w.

1803. Rare Minerals of the South (Some information relating to the various minerals, where they are found, and their commercial importance). Mfrs' Rec-Oct. 4. 4500 w.

1806. The Necessity of Competent Geological Surveys of Gold Mines (Abstract of a paper by Nicol Brown, read before the Geologists' Asso. of London, showing that a knowledge of geology is of first importance in exploiting for gold). Can Min Rev-Sept. 1200 w.

*1820. Coal Mine Explosions and Coal Mine Fires; Their Occurrence and Suppression. Ill. D. A. Louis (Fire-damp explosions, coal-dust fires and spontaneous conflagrations considered). Knowledge-Oct. 1. 4000 w.

*1824. Determination of Strength of Cyanide Solutions. Mr. Bethel (A paper read before the chemical and metallurgical society on some quick volumetric methods of analysis of McArthur-Forest Cyanide Solutions). Min. Jour-Sept. 28. 2200 w.

1826. Fractional Precipitation of Gold from a Solution Carrying Gold and Copper, with Hydrogen-Sulphide Gas. John E. Rothwell (Some results from actual practice by the process of fractional precipitation). Eng & Min Jour-Oct. 5. 900 w.

†1862. The Formation of Coal. Homer Greene (Interesting geological consideration of this subject). New Sci Rev-Oct. 3800 w.

1881. The Chinese in Our Gold Mines. Dan De Quille (An interesting account of the work of the Chinese in the mines, from their first coming to the present time. The author considers it a great mistake to have allowed them to do anything in the shape of mining, and thinks, all things considered, that they have no reason to complain of this country). Min Ind & Rev-Oct. 3. 2600 w.

MUNICIPAL ENGINEERING

Testing Water Meters,

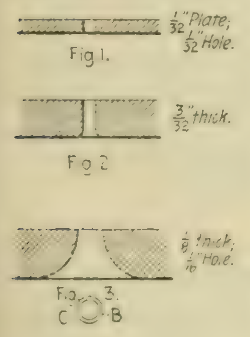
THE time will come when the distribution of water to consumers in all large municipalities will be measured by meters, as is now that of gas,—that is, the use of water meters will be extended to the supply of private establishments as well as to large public buildings, hotels, office-buildings, manufactories, etc. No one with any show of reason can dispute that this is the only way whereby the cost of supply can be equitably apportioned, and wasteful consumption prevented. Those who do not have to pay in proportion to what they use and waste will, as a rule, continue to be wasteful, and the time is approaching fast in our larger cities when a limit to waste must be instituted.

This premised, we see that the subject of uniform methods of testing water meters, ably treated in a paper by Mr. John Thompson before the Burlington meeting of the New England Water Works Association, and printed in a slightly condensed form in *Engineering News* (Sept. 19), is not only of present importance, but will be even more important in the future. The questions asked and discussed by Mr. Thompson imply the points of difference in present methods.

"(1) Should not the rating of meters, especially in low-flow tests, be by timing the deliveries of definite quantities, rather than by designating the diameter of jets? (2) What shall be the limit of the minimum rate? (3) What shall be the limit of the minimum rate? (4) Should tests be referred to the meter on the tank? (5) Should the error be indicated in pounds or percentage?"

He asserts that "low-flows should be designated by time rating," giving as reasons that time rating "is correct in theory" and that its superiority over other methods has been "demonstrated by long practice. . . . In testing a meter at low flow the only point desired to be known is what quantity is passing per minute or hour. If one meter, to operate accurately, requires a draft of 2 cu. ft. uniformly drawn in 1 hour, and another meter operates with equal accuracy upon a draft of 1 cu. ft. in the same time, then the latter has twice the sensibility of the former. The only function of a throttling diaphragm is to determine the rate of flow, and the only way of determining this is to carefully rate the perforation by measuring its discharge under a definite pressure for a definite period of time."

The variations of delivery through diaphragms of different thicknesses and having differently-shaped orifices are illustrated by Figs. 1, 2, and 3. Fig. 4 illustrates standard meter-testing diaphragms proposed by Mr. Thompson. "In Fig. 1 is represented, to large scale, a diaphragm, the original of which is 1-32 in. thick, the perforation being precisely 1-32 in. diameter, with the edges knife-sharp. The delivery of this orifice under a pressure of 50 lbs. per sq. in. is approximately 1 cu. ft. per hour. In Fig. 2 a diaphragm is represented to the same scale as Fig. 1, the original of which is 3-32 in. thick, having precisely the same diameter of orifice and the same knife-sharp edge on the upper side, but with the lower edge very slightly rounded by lightly scraping the edge with a sharp knife. The delivery of this diaphragm, under the same pressure as the former, with the upper sharp edge of the flow, is nearly 1.12 cu. ft. an hour. Hence the difference in thickness alone gives the thin diaphragm, at the pressure named, 12 per cent. less delivering capacity than the thicker one. Again, with this diaphragm reversed, the slightly rounded edge to the flow, the delivery is nearly 1.5 cu. ft. per hour, or 33 per cent. greater delivering capacity than from the sharp edge. These examples show how apparently trivial differences may greatly affect the comparison of results. Again, referring to Fig. 3, a diaphragm is represented in the original, of which the perforation is precisely 1-16 in. diameter, the thickness ⅛ in., one edge knife-sharp, and the other very nicely rounded to a curve of about ⅛ in. radius. This diaphragm, under a pressure of 50 lbs., each side being separately presented towards the pressure, gave the following results: with the upper edge to the inlet, the delivery was about 5.3 cu. ft. an hour; reversed, with the lower rounded edge to the flow, the delivery was about 7.10 cu. ft. an hour, or nearly 34 per cent. greater than the first. The well-known reason for this difference in delivering capacity is indicated in the circles *C* and *B*, the inner circle *C*, denoting the area of the contracted jet, from the sharp edge, while the outer circle, *B*, denotes the stream from the rounded side equal to that of the area of the orifice.



1, 2, 3. Diagrams Illustrating Results with Different Forms of Orifices in Meter Testing Diaphragms.

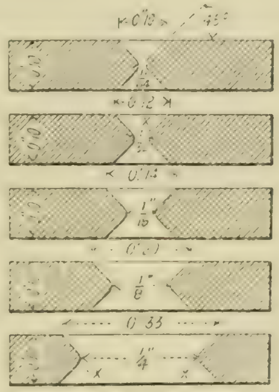


Fig. 4. Proposed Standard Meter Testing Diaphragms.

"The practical application of this to the present subject is as follows: suppose two meters equally accurate at 7 ft. an hour, and equally inaccurate at 5 ft. an hour. Then, furthermore, suppose that two water-works are supplied with these meters, requiring them accurate, according to their specification, on a jet 1-6 in. diameter at 50 lbs. pressure, and that it so happens that one of these works is provided with a diaphragm, sharp, as the upper side of Fig. 3, and the other works with a rounded perforation, as the lower side of said figure. Obviously, the works using the sharp-edged diaphragm will find the meter defective, whilst the other will accept its twin as correct. Evidently, had the meters been ordered to be correct at a minimum rate of 5 cu. ft. an hour, and had then been tested respectively under conditions to obtain this rate of flow, each purchaser would have been equally suited."

The standard diaphragms proposed are shown on an enlarged scale in Fig. 4, which gives their essential dimensions. The material named for them is hard-rolled brass. Of course the utmost care is demanded that the holes shall be made to exact dimensions, this being an operation within the skill of any good mechanic. "Both sides are made alike, in order that either side may be presented toward the inlet, and that the throat may be protected from injury."

Mr. Thompson then discusses "the limit of minimum rate," and describes, as illustrated in Fig. 5, a graduated valve for testing meters by time-rating; and in Fig. 6 he illustrates a meter-testing apparatus consisting of a galvanized iron can of 2 cu. ft. or 15 gallons' testing capacity, suspended by a bail on trunions from a spring scale, and having its inlet provided with a valve and standard diaphragm.

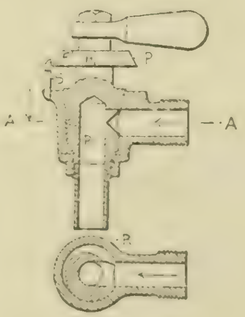


Fig. 5.

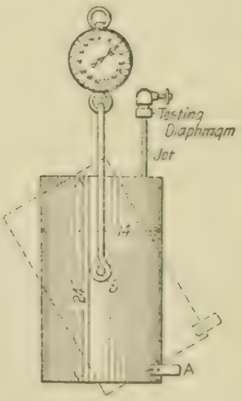


Fig. 6.

Fig. 5. Graduated Valve for Testing Meters by Time Rating.

Fig. 6. A Simple and Accurate Meter Testing Plant.

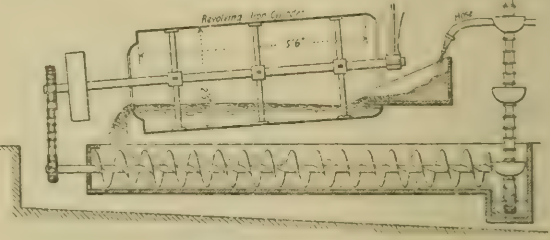
The "limit of the minimum rate" should be adapted to the conditions of the service. But the following general recommendation is ventured: "When the water is reasonably pure and free from grit, it is believed to be well within the power of manufacturers to regularly supply the smaller sizes of positive rotary and piston meters to indicate within 3 per cent. of accuracy at the rate of 1 cu. ft. uniformly drawn in 1 hour. And a meter which will do this may generally be depended upon to indicate, though not necessarily with much accuracy, down to from ¾ to ½ cu. ft. an hour. But the insistence upon such a degree of sensibility, except only where the water is free from grit, may invariably be taken as indicative of anything except good engineering sense." As to maximum rate practice differs widely; but, for sizes of service pipes of ½", ¾" and 1", a velocity of flow of 15 lin. ft. per second, representing respectively discharges of 1.8, 2.8, and 4.8 cu. ft. per minute, is considered as high as good practice will warrant; or, say, 2 cu. ft. for ½" or ⅝" meters, and 3.5 cu. ft. for a 1-in. meter. It is preferable to throttle the meter at the outlet, as this keeps the meter full under a regular pressure. Water should be turned on to an empty meter slowly, until the meter is completely filled," and "it is preferable to run a small quantity through the meter before starting a test." Measuring a discharge in tanks provided with glass tubes is liable to error from the capillarity of the tubes. Many other practical considerations and precautions are noted; and it is made evident that the accurate testing of water meters is not so simple and easy a matter as some have thought it to be.

The Hudson Water-Works Sand Washer.

In reply to a request for information made by the editor of *Engineering News*, Mr. George A. Soper of Gardner Road, Brookline, Mass., sent a drawing and description of a machine employed at the filter beds of the water-works at Hudson, N. Y. These were printed in the Sept. 12 issue of that journal. A striking feature in the operation of this machine is the remarkably low cost of cleansing sand by its use. Mr. Soper writes of it as follows:

"While I did not make a bacterial examination of the cleansed sand in connection with my recent investigation of the filter plant, and cannot in consequence state the percentage of bacteria removed, a general inspection of the method employed and of its apparent results satisfied me that the washed sand was quite clean enough to admit of a high efficiency of purification by the beds.

"There are two filters at Hudson, the larger one of which I shall take for illustration. Its area is a little less than a half-acre. To remove its carpet of sludge, together with about ¾ in. of sand, to a distance of 6 rods takes eleven men 9 hours, working with broad-bladed shovels and wheelbarrows. The sand is dumped into a bin freely exposed to the air, where it lies until successive cleanings of the bed necessitate a larger supply of available material for its renewal.



SAND WASHER.

"The bin for dirty sand immediately adjoins a small frame building, which contains the sand washer. When in operation, the sand is shoveled from its bin through an open door in the building upon a stage which acts as a kind of hopper. From the stage it is introduced into a revolving iron cylinder 2½ ft. in diameter by 5½ ft. in length, shown in the accompanying illustration. A copious stream of water and a slight inclination from the horizontal assist in causing the agitated sand to traverse the length of the cylinder, where it falls into a wooden trough 1 ft. square in section, and running parallel to the cylinder immediately beneath it. The trough being closed on both ends, and there being an abundant supply of water, a constant overflow takes place along its entire length, while the sand itself, sinking to the bottom, is conveyed back to the open doorway by means of a revolving iron helix fitting closely to the side of the trough. The overflow is relied upon to carry off the filth disengaged from the sand by attrition and immersed in the water. Finally the sand is raised by an endless chain of buckets through the doorway to an outside platform 30 ft. above, and is there collected in wheelbarrows and dumped in a pile convenient to the filter bed. The engine is of 4 h. p. capacity, the boiler is of 5 h. p. capacity, and they easily turn the cylinder and the helix, and operate the buckets and pumps.

"When running, four men are employed at daily wages of $1.50, and the keeper and superintendent also lend their assistance. In this way about 32 cu. yds. of sand may be cleaned per day at a cost of about 20 cents per cu. yard. Supposing the maximum record rate of filtration, and remembering that for 2 months of the year the beds do not act as filters because of the impossibility of cleaning due to the frost, the cost of cleaning the sand may be estimated at about 16 cents per million gallons of filtered water. This is about 13 per cent. of the total cost of removing the dirty sand, washing it, and replacing it upon the beds."

Recent Improvements in Lighting.

THE following is an abstract of an address to the Association of German Engineers delivered by Dr. Wedding (*Gas World*, Aug. 10).

Dr. Wedding said that the Tesla light, though no doubt it will come,—in the next generation perhaps,—has not yet developed into anything practical. The chief interest of the address is in the numerical data, which afford a useful basis of comparison.

"A Welsbach lamp uses, on the average, 1.83 liters of gas (0.0646 cu. ft.) per candle, rising to 2.50 liters (0.0883 cu. ft.); most of the other incandescent lamps use from 3 to 5 liters to begin with, and go up to 6 liters, when the Welsbach is yet up to 2 1-2. In Trendel's Diamond light the consumption is under 2, and reaches 3 only after 200 hours, at which time the Welsbach is slightly under 2. Butzke's lamps are progressively improving: the earlier samples were 50 per cent. more than Welsbachs in respect of their consumption of gas; the latter only 17 per cent. The Butzke gives only about two-thirds the light of a Welsbach; it therefore uses actually less gas; and 60 candles is often too much, so that a Butzke may do well enough in many situations. Butzke's light is reddish; Kramme's is very white; Welsbach's is variable, for some parcels are white to greenish, others are yellowish to reddish; but all the competing makes seem to give a redder light, and a more pleasant one. But it must be remembered that the same quantity of energy, as red light, giving a visual intensity-energy measured as 1, will give, as yellow light, a visual intensity-energy of 28,000, as green light 100,000, and as violet light 1,600; whence it is important for illumination to economize energy by sending it out as green light. Acetylene, burned with air in a Berlin street lantern Bray burner (14 cu. ft. of gas, 40 candles), 47 per cent. acetylene, 53 air; light, 52 candles; consumption, 0.81 liter (0.0285 cu. ft.) acetylene per candle; consumption per candle increased 50 per cent. by diluting the acetylene with carbonic acid instead of air. Enrichment, plain gas, 15 liters (0.529 cu. ft.) per candle; 4 per cent. acetylene, 7 liters (0.247 cu. ft.); 12 per cent., 4 liters (0.142 cu. ft.); 21 per cent., 3 liters (0.106 cu. ft.) per candle.

"The order of cost is; arc lamps, per 16 candles, 0.60d. per hour; Welsbachs, 0.06d. to 0.84d.; spirit Welsbachs, from 0.84d. to 0.24d.; petroleum (at 19⅔d. per gallon), about 0.24d.; argand gas, about 0.3d.; electric incandescent lamps, 0.433d.; acetylene at present prices (carbid 6d. per kilogram) in a regenerative burner (0.026 cu. ft. per candle), 0.6d. per hour. Recent makes of very small arc lamps (Niewerth and Co.) give an average of 40 candles (maximum 65) with a consumption of 40 watts per hour: that is, where current costs 5d. per Board of Trade unit, an hourly cost per 16 candles of 0.08d., with the advantage that the rays are better reflected from the walls and things look brighter than amid the predominantly green rays of a Welsbach, which are not well reflected from dark walls and objects,"—a fault in this lamp not generally appreciated.

The Hermite Process of Purifying Sewage.

THIS process was the subject of a paper by Mr. J. Napier, read before Section G, of the British Association, at its late meeting, an abstract of which is contained in *Engineering* (Sept. 20). The process appears to have merit, and an outline of its nature and mode of application is timely. "Hermite" is a trade name for a deodorizing and disinfecting solution which, it is claimed, can be made cheaply enough to warrant its use for deodorizing sewage on a large scale. The process of manufacturing it consists of passing an electric current obtained from a dynamo through sea water or a solution containing magnesium and sodium chlorids. A portion of the chlorids is converted into hypochlorite,—a substance which disinfects, deodorizes, and bleaches in a way similar to that in which the active ingredient of bleaching powder acts. This solution is called the electrolyzed or "Hermite" solution, and may contain from ½ to 1 gram of active chlorine per liter. The author gave a brief history of the sewering of Ipswich during the last 20 years, showing the present system, particularly the position of the main sewer as it passes through the town to the outfall. The deodorizing effects of the solution on sewage, especially upon that in the main sewer of Ipswich, were dealt with, and the results of trials made in August and September, 1894, and in June and August of this year were given.

In the discussion that followed the reading of the paper, Mr. T. S. Elliston remarked "that in the electrolyzed sea water there was a powerful deodorant, and also a strong disinfectant that could be manufactured in bulk at a small cost. He urged that the plant should be sufficient to electrolyze the solution in the full strength of 1 gram of active chlorine per liter. He put 950 gallons of the strong solution of 1 gram per liter at the head of the main sewer, and for more than ½ mile could distinctly trace the chlorine smell at the manholes. A sample of the sewage was taken out after being treated, and was found to contain 5 per cent. of the solution. After it had stood 6 days, it showed no signs of decomposition, whereas a sample removed a short time before the solution was added was offensively putrid at the time. This he considered a very satisfactory result. They were only trying the main sewer, it being thought that the sewer gas was generated there and driven up the arterial system. In the speaker's opinion sewer gas was extensively generated in the arterial system of sewerage, and became equally offensive there. When sewers were complained of, it was often the fault of the house drain. Mr. Elliston would like to see sufficient plant put down to work the solution up to its full strength, and to have a reserve for treating special localities. There was one advantage of this system,—that it acted as a flushing system. After a hot dry summer, the subsoil became warmed so that, as the temperature of the sewers rose to 55 deg. Fahr., or thereabouts, the putrefying changes in the sewers became more rapid, and the flushing of the sewers constantly with the fluid not only acted as a deodorant, but reduced the temperature as well."

MR. JAMES MANSERGH, M.I.C.E., is to report on the waterworks system of the city of Toronto, which, it is said will take him a month to complete. Toronto has a population of 200,000, and is deprived of its water supply owing to a break in the conduit pipe by which water is procured from Lake Ontario. The necessary repairs cannot be effected for several weeks. In the meantime water is being procured from the surrounding villages, whence it is carried to the city by means of puncheons, barrels, and watering carts, the public being put to very serious inconvenience.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Gas Supply.

*1413. Some Experiences in Gas Purification. R. G. Shadbolt (Attempts to reduce cost. Results attained. Discussion by members). Gas Wld-Sept. 7. 5000 w.

1446. Mechanical Stoking in Retort-Houses

(An able review of progress in mechanical stoking of gas retort furnaces. Abstract of papers read respectively by Alexander Wilson and Andrew S. Biggart). Pro Age–Sept. 16. 3000 w.

1447. A Chart of Active Gas-Securities (A graphical indication of prices of gas stocks from Jan., 1895, to June, inclusive). Pro Age–Sept. 16. 1500 w.

*1465. The Bradford Oil-Gas Controversy (Interesting and Important. Gives report of expert, Mr. Lewis T. Wright, upon Dvorkovitz oil gas process, to the South-west of England District Association of Gas Managers; report of Mr. Thomas Newbigging, expert in the interest of the promoters of this process; a supplementary report by Mr. Wright; a reply to this report by Mr. Newbigging, criticising Mr. Wright's supplementary report and pointing out an alleged mistake in his calculation; a criticism of Mr. Wright's report by the corporation gas engineer; and the terms of an offer made by the agent of the owners of the Dvorkovitz patents, in which a guarantee is made that the cost of enrichment by this process shall not exceed one half-penny per candle-power for every 1000 feet of gas supplied for consumption. Followed by a long discussion). Gas Wld–Sept. 14. 11000 w.

*1476. The Manufacture of Sulphuric Acid by Sulphate of Ammonia Makers. Fletcher W. Stevenson (Describes a profitable industry which can be carried on by makers of sulphate of ammonia, the sulphur of the sulphuretted hydrogen being converted into acid). Gas Eng Mag–Sept. 10. 3300 w.

*1634. The Manufacture of Sulphate of Ammonia (A discussion at a meeting of Eastern Counties' Gas Managers Asso. (English) on the feasibility, profits and practical methods of manufacturing sulphate of ammonia in small works). Gas Wld–Sept. 21. 2500 w.

*1635. The Bradford Oil-Gas Controversy. Interview with Dr. Dvorkovitz (The Dvorkovitz oil-gas process having been pronounced a failure by the Bradford (Eng.) authorities, upon an adverse report of an expert employed to investigate its claims and its practical results, this interview affords the opportunity for a criticism of the report by the inventor. The adverse report has also been criticised by other authorities and it is questionable whether the report is not as likely to aid the introduction of the new process as to retard it). Gas Wld–Sept. 21. 2700 w.

1711. Recent Appearances upon the Field of Illumination by Gas. H. Bunte (From report of a paper read at Cologne, before the 35th annual convention of the German Union of Gas and Water Engineers. The first number discusses argon, thorium and calcium carbide). Pro Age–Oct. 1. Serial. 1st part. 4500 w.

1712. Tests of the Welsbach Incandescent Burner. E. V. Stebbins (Abstract of a thesis in Elec. Engng., Sibley College. The object of tests was to determine the general properties of the lamp, including its life curves; its candle-power; the deterioration in the same and in its color; its radiant efficiency; the difference in the parts of its mantle; the absorption by various globes in common use; and, generally, its properties and powers as a source of light). Pro Age–Oct. 1. 2000 w.

1744. The Browne Gas Process. Ill. (The vaporizing of petroleum and passing it through incandescent heat). Ir Age–Oct. 3. 600 w.

*1853. M. Bansept's Gas-Mixing Method (Describes a method of gas mixing, whereby, it is claimed, a mantle of more solid material than is used in the Welsbach system may be employed, and a noteworthy increase of illuminating power may be gained). Gas Wld–Sept. 28. 2200 w.

Sewerage.

1415. The Proposed Sewerage of Independence, Mo. (Abstract of a report of the designing engineer, Mr. Wynkoop Kiersted). Eng Rec–Sept. 4. 1100 w.

†1435. Sewage Disposal in Small Towns—Practical Examples in England.—Cardiff (Abstract of Consular Report to the State Department). San–Sept. 2200 w.

*1636. The Drainage of Villages. William Spinks (The first number deals principally with statutory powers before entering upon the engineering side of the question, which will be discussed in future numbers). San Rec–Sept. 20. Serial. 1st part. 1400 w.

*1681. The Hermite Sewage Process (Paper read before the mechanical section of the British Asso. by J. Napier, with discussion. Both the paper and discussion give practical experience favorable to the process, which consists in deodorizing sewage by the action of hypochlorite produced by the action of the electric current upon the chlorides contained in sea-water). Engng–Sept. 20. Serial. 1st part. 1000 w.

†1832. The Disposal of Sewage for Industrial Communities in India (Describes the system of dry earth latrines in use in India, which is said to be perfectly sanitary and very satisfactory). Ind & East Eng–Sept. 7. 2000 w.

1871.—$1.50. The Separate Sewer System Without Automatic Flush Tanks. F. S. Odell, with Discussion (An argument to prove that automatic flush tanks are not an essential feature of a separate sewer system, and that where any sufficient reason exists for their omission, as where water supply is insufficient, or too costly, they may be dispensed with). Am Soc Civ Eng–Sept. 4200 w.

Streets and Pavements.

1675. Street Cleaning in Germany (Reprinted from the *Surveyor*. Describes methods of street cleaning. (1) Where the cost is borne by the municipal authority. (2) Where borne by owners of property along the line. (3) Where shared by owners of property and the community. The methods in forty-two German cities are quoted). Eng Rec–Sept. 28. 900 w.

*1713. Differences in Specifications for Vitrified Paving Brick. W. G. Wilkins (The author gives a large amount of useful information drawn from personal experience and investigations of specifications in use in different municipalities; these investigations having been made for the purpose of improvement in his own specifications as chief of the bureau of engineering and surveying in the city of Allegheny, Pa. Paper read at the Soc. of Municipal Improvements, with Discussion). Paving & Munic Engng–Oct. 2800 w.

*1717. Experience in Several Cities with Brick Paving (A general discussion by members of the Am. Soc. of Munic. Improvements relating to practice in various municipalities). Pav & Munic Engng–Oct. 1000 w.

Water Supply.

*1309. The Pike's Peak and Colorado Springs Water Works. Ill. Arthur Lakes (An account of the drainage system, existing and contemplated, for the supply of water to Colorado Springs from the lakes of Pike's peak, including a description of the "iceberg idea"). Eng Mag–Nov. 3000 w.

1356. Sand Washer for the Filter Beds of the Water-Works of Hudson, N. Y. George A. Soper (A communication describing and illustrating a machine for washing the dirty sand removed from filter beds). Eng News–Sept. 12. 450 w.

1359. Electrolytic Corrosion of Water Pipes in Boston (Results of the investigation of experts on the effect of electric ground currents upon water pipes. Embodied in the An. Report of the City Engineer of Boston). Eng News–Sept. 12. 500 w.

1378. New Jersey's Watersheds (Estimate of the supply from various sources; correction of some errors relative to these sources, and suggestion that by draining some wet lands in the state, the poor farmers along the Ramapo River might be induced to vacate their impoverished lands along the banks for the more fertile drained lands, thus removing one source of pollution). Fire & Water–Sept. 14. 1100 w.

*1423. Bouches-du-Rhone Colliery Outfall Drift—Difficulties from Feeders (A scheme for obtaining water supply from the outfall drift named, for the city of Marseilles, with a population of 400,000. An extremely interesting article). Col Guard–Sept. 6. 4800 w.

1462. Uniformity of Methods in Testing Water Meters. John Thomson (Investigation of best method to measure water supplies, with cuts showing orifices used, also a graduated valve meter and graduated tank meter). Eng News–Sept. 19. 4200 w.

1464. The Milwaukee Water-Works Intake. Ill. (Construction of a tunnel under unusually difficult conditions. A very interesting description of an 8200-ft. submarine intake into Lake Michigan). Eng News–Sept. 19. 4200 w.

†1549. Water Supply in 1894 (Editorial. Takes the ground that the bacteriologist will supersede the chemist in the determination of the wholesomeness of water, the chemist's duties ceasing with the primary analysis of the constituents before the source of supply is decided upon). Ind Engng–Aug. 17. 1400 w.

*1658. The New Westminster Waterworks. Arthur Edmund Breton Hill (From Pro. of Inst. of Civ. Eng. of Eng. History, description and itemized table of cost of the works up to Dec., 1892, in which year the water was turned into the main). Eng, Lond–Sept. 20. 1300 w.

1674. Municipal Provision of Hydrants (Gives the number of fire hydrants per mile, and the number per thousand of population, for more than twenty American cities). Eng Rec–Sept. 28. 200 w.

*1714. Impurities in Public Water Supplies. John W. Hill (A broad review of the subject. Paper read before the Am. Soc. of Munic. Improvements, followed by discussion). Pav & Munic Engng–Oct. 3600 w.

1870.—$1.50. Consumption and Waste of Water. Dexter Brackett, with Discussion (Gives a tabular statement of water in different municipalities which shows that rate of consumption is increasing more rapidly than population. Also tabulated statement of water used for domestic purposes from which data it is concluded that on an average at least 50% of the water consumed in American municipalities is wasted. Causes of waste separately discussed, and for which remedies must be found, are defective plumbing, defective street mains and services, waste for preventing freezing of services, and wilful waste). Am Soc of Civ Eng–Sept. 12000 w.

1872.—$1.50. Experiments on the Discharge of a 30-in. Stop Valve. J. Waldo Smith, with Discussion (Tabulated results and diagrams showing graphically coefficients of discharge, and cuts illustrating arrangement and construction). Am Soc Civ Eng–Sept. 2400 w.

Miscellany.

1419. The Manufacture of Paving Brick in Central Iowa. L. Balliet (Quality of clays; general geological section in the region of Des Moines; kilns; mixtures, etc). Eng & Min Jour–Sept. 14. 1500 w.

*1682. Public Hydraulic Power Supply. Edward B. Ellington (Review of the municipal hydraulic power now supplied in a number of cities. This first number deals with the system as carried out in Glasgow). Engng–Sept. 20. Serial. 1st part. 2500 w.

*1715. Experience with Improved Streets and Sewers. W. B. Holton (Recounts instructive experiences in Indianapolis. Paper read before the Am. Soc. of Munic. Improvements, followed by discussion). Pav & Munic Engng–Oct. 3000 w.

*1716. Disposal of Garbage. Thomas De Vilbiss (Paper read before the Am. Soc. of Munic. Improvement, with Discussion. Treats of collections, the character of vehicles used for this purpose, and systems for destroying and disposing of garbage. Interesting experiences are narrated). Pav & Munic Engng–Oct. 4000 w.

1793. Garbage Collection and Disposal at Pittsburg, Pa. (A detailed description of the system, with illustrations of garbage wagon. Disposal is effected by the method of the American Reduction Co., in which the material is first treated with steam in digesters, and subsequently dessicated for use as a fertilizer). Eng News–Oct. 2800 w.

RAILROADING

American and British Railways Compared.

THE *Railway Age and Northwestern Railroader* (Sept. 13) contains an interesting compilation of figures from Poor's Manual of American railroads and the British board of trade returns for English railroads, with editorial comment. The operating conditions in these two nations are quite dissimilar, and for that reason the figures given are instructive, as showing the relation between capitalization, mileage, and passengers and freight carried. "The following are the principal items from the two reports which are capable of comparison :

For the year 1894.	United States.	Great Britain.
Miles of railway.........	179,279	20,908
Capital stock and debt...	$11,565,600,000	$4,926,936,000
Earnings—passenger. ..	276,031,571	154,312,529
" freight	700,477,409	216,895,390
" other...... .	91,134,533	28,164,795
Total traffic revenue.....	$1,067,643,513	$399,372,714
Operating expenses......	757,765.739	236,041,565
Net earnings	309,887,774	163,331,265
Passengers carried.......	583,248.007	*911,412,926
Tons freight moved......	675,129,747	324,416,222
Rd. & equip't. Cost pr m.	55,641	235,648
Earnings per mile.......	6,085	19,100
Exp. to earnings. Per ct.	70.24 p. c.	56.00 p. c.
Pas'r earn'gs. Pro. of gr.	25.85 "	43.29 "
Freight " " " "	65.61 "	51.45 "
Other " " " "	8.54 "	5.26 "
Int. and div's on capital.	2.89 "	3.77 "
Locomotives, number....	35,813	18,328
Passenger cars, " ...	26,345	41,500
Bag. & mail cars, " .. .	7,937	16,161
Freight cars ..	1,191,866	608,079

*Also 1,184,861 holders of season tickets.

"It will be seen that, while our mileage is nearly nine times that of the United Kingdom, our railway capital is only two and one-third times as great, our gross earnings are but two and two-thirds times as great, and our net earnings lack considerable of being twice as great. But, as for passengers carried, the British roads beat us nearly two to one, without counting the unnumbered trips of 1,184,000 British season-ticket holders ; and, although our foreign tonnage is more than twice as great as theirs, the earnings per mile of road were considerably more than twice as great in Great Britain as in the United States. The better results in net earnings on British roads are largely accounted for when it is seen that our operating expenses are very much larger per mile than theirs, standing at over 70 per cent. against 56 on British roads. With such a difference in the ratio of expenses, it is not strange to find that the British roads last year earned 3.77 per cent. on their much heavier rate of capitalization, while the rate earned by American roads averaged only 2.84 per cent. But it is also a very important fact that the earnings of our roads averaged only $6085 per mile, compared with $19,100 per mile earned by British roads."

Gas Street Railway in Dessau.

IN a recent number of the *Progressive Age* (Sept. 16) General Superintendent W. von Oechelhaeuser describes the street railway of Dessau, Germany, which is operated by gas engines entirely. The line was originally 2¾ miles long, and went into operation in November, 1894, with an equipment of nine gas motor cars. It now has a mileage of 3⅞ miles, and nine 7-h. p. and four 10 h. p. motor cars, with four tail cars. As gas engines need neither water or coal, which are sometimes not very available in isolated localities, the gas engine has received considerable attention, especially from mining men, but its direct competition with steam and electricity is rather a rarity. The author states that "the three chief elements in gas-traction are : the gas-storage, the gas engine, and the driving-mechanism ; and of these the public is accustomed to take the greatest interest in gas-storage. It is here important, before all things, to remove a prejudice (namely, the fearful spectre of a supposed danger of explosion) by bringing it so closely home that we can recognize it as in fact it is,—as an apparition without real existence. For facts show that the transportation of gas under high pressure, and its burning during transit, has taken place for more than 25 years with the well-known and excellently-chosen Pintsch system, in more than sixty thousand railway passenger cars, at home and abroad, actually without a single explosion; and that no one who travels in these cars thinks of danger of explosion or has the slightest reason for doing so. . . . . The second point of interest in relation to the question is: will the wear and tear of gas engines, operating gas street railways, not be too great? Naturally the first half-year's operation, as in Dessau, can give no direct answer to this question from experience. We are in a position, however, to draw indirect conclusions from the operations of stationary gas-engines. In this connection, the company which I represent has undertaken an inquiry of all the owners of such, and of some of the larger gas-engine shops outside of our company, resulting in a reply exceptionally favorable. From most of the owners the almost stereotyped answer came back that in most cases the repairs were limited to the replacement of piston-rings after a considerable period of operation, to the re-scraping of slide valves (of the engines of older construction, the later motors possessing poppet valves almost entirely), and to re-packing joints,—a point which can be cared for with an insignificant cost of material and by the ordinary personal attendance. The reports from gas-dynamos are also very favorable." The author shows that at the electric central station at Dessau the cost of repairs during a period of 8½ years, for the 10, 30, 60, and 120 h. p. motors, has been less than 1/10 of a cent per horse-power per hour, or one-eighth of one per cent. of their first cost per year. The 350-h. p. gas engines at the station at Sophia Island at Prague, during a period of 8 years, cost nothing for repairs, while the 12-h. p. gas engine at the State House caused an expenditure of $37.20 in a period of 9 years. "A brief inspection of the gas engine of the Dessau cars has shown that the working cylinders are as smooth as a looking glass inside, and reveal to the gaze not the least alteration of dimension or unequal wear in the two ends of the cylinder, which fully establishes from this first half-year's operation that we have nothing to fear from dust. The driving mechanism is protected from dust and dirt by a special casing." A charge of gas will run the engine 6 to 8 miles. Ordinary illuminating gas is found more desirable than the richer gases. The consumption of gas per car-mile is 16.58 cu. ft., the quantity used at the compression plant bringing it up to 18.37 cu. ft. Details of operation are shown by the following table:

DATA OF OPERATION OF THE DESSAU GAS STREET RAILWAY.

Month. 1895.	Number of motor-cars in daily use.	Useful car-miles.	Number of passengers carried.	Volume of compressed gas.	Gas-consumption of engines driving compressors and work-shop.	Total gas consumption for power.	Gas compressed per useful car-mile.	Total gas used per useful car-mile.	Percentage of compressed gas used in compr.
				Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	Cu. ft.	
January....	7	13,038	47.250	356,967	63.864	420,831	16 97	20.04	14.6
February....	7	12,476	35,995	335.590	56.342	391,932	16 69	19 48	13.9
March......	8	14,513	52.470	388,197	64,005	452,202	16 58	19 33	12.8
April.......	8	14,579	61,900	382.050	61,252	443,302	16.26	18 88	11 9
May........	8	16,489	70.552	439.254	72.057	511,311	16.51	19.23	13.5
		71,095	268 167	1,902.058	317.520	2.219 578	16 58	18.37	

Norfolk & Western System of Maintaining Standards.

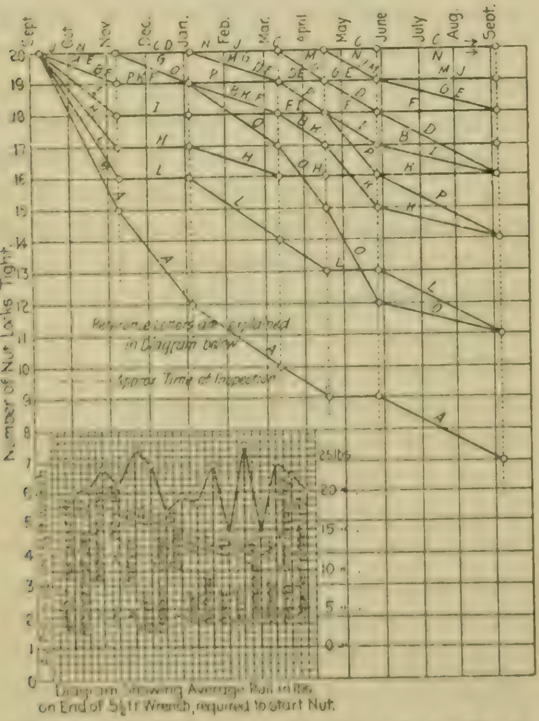
OVER the initials A. S. in *Locomotive Engineering* (Sept.) we find some interesting notes on a subject which all acknowledge to be of great economic importance, and which few roads possess in such a well-developed state. The department of motive power is under a man who has systematized the work thoroughly; all material purchased or handled is subject to chemical and mechanical tests in a specially-designed laboratory; drawings are arranged according to classified catalogue; and the store house and shop management have complete records of material and labor. "Perceiving the advantage it would be in the interest of uniformity that every man in charge of repairs should possess a record of standards adopted or of changes made on existing standards, Mr. Soule, the superintendent of motive power, instituted a system of circular 'notifications of standard,' which is sent to every official in charge of work. These notifications of standards give a brief description of the form adopted, and refer to the blue print, which contains full particulars. The notifications are sometimes of standards adopted, and at other times they relate to standards changed or to new designs. Occasionally they notify all concerned of a new style of some article which has been adopted, or a changed location for some attachment. One of the latest notifications reads: 'Hereafter counterbore bolts, as per print S. C. 97, should be used in locomotive construction and repairs, instead of countersunk bolts such as have hitherto been generally used. These counterbore bolts should not only be used in all new work, but should also be used in renewals of old work whenever possible.' The total number of these notifications has been about three hundred and fifty. They relate to every variety of detail of locomotives and cars. As these notifications would be confusing after they became numerous, they have been indexed, so that a master mechanic, car-builder, or general foreman, wishing to know what has been done concerning any particular part, turns up the index and has the information at once. . . . The practical effect of the system is the promotion of uniform practice in the repair shops and a tendency to make parts interchangeable. This reduces the cost of repairs, and facilitates doing so much of the work promptly that the clerical expense of keeping the system going cuts no figure."

The Baltimore Tunnel Electric Locomotive.

SPECULATION is active in electrical circles in all its phases, from the visionary to the practical, concerning the place the electric motor will occupy in passenger and freight traffic. The direct cause is the placing of a large electric locomotive in the tunnel leading into Baltimore, where it is now successfully doing the work of a steam locomotive. *The Railroad Gazette* (Oct. 4) states that "the contract requires the engines to haul fifteen loaded passenger cars and a locomotive at 35 miles an hour, and thirty loaded freight cars and locomotive at 15 miles an hour, through the tunnel up an 0.8 per cent. grade; the object is to keep the tunnel free from locomotive smoke, which would, of course, be aggravated when pulling up the grade. . . . Going westward, the trains run through without steam, the grade descending at 42 ft. per mile all the way." The successful working of this motor under heavy loads has led many to jump at the conclusion that the electric motor will in the near future displace steam locomotives in railroad service. The trend of the views of those qualified to advance opinions has been to the effect that electricity cannot be profitably used for heavy through traffic, but will monopolize local passenger trade and handle light local freight. The article says that, "whatever may be the outcome of the use of electric locomotives in the Baltimore tunnel, there is one valuable practical lesson already,—*viz.*, there is a possibility of getting any reasonable pull with an electric locomotive. This fact will be impressed on the mind of any one who sees the machine take hold of a train of thirty cars and start them without using the slack. A far better example is found in suburban street-car lines. It has been said in the press reports that the Baltimore electric locomotive has reached 61 miles an hour. This is quite probable, as there is sufficient power to drive the locomotive and several cars at 100 miles an hour, if the motors were all placed in multiple instead of series." It will be interesting to watch the growth of this new departure.

Efficiency of Track-Bolt Nut Locks.

MUCH in the same way that illustrations and drawings are taking the place of written descriptions, the results of experiments are being expressed in diagrams, which not only are understood at a glance, but separate and condense what we wish to know from a wearisome collection of recorded observations, many of which require corrections and allowances. This system of condensation, and this effort to make complicated things easily understood, are evident, we are glad to say, with most of our best modern scientific writers, while the devotees of the infinitesimal calculus and Latin phrases are rapidly becoming obsolete. We have an example of systematic work in a paper by Mr. G. E. Hayward, part of which is published by the *Engineering News* (Oct. 3). The record of these tests is given in the accompanying diagram, while the methods of making the experiments are thus explained :



Diagrams of Efficiency of Nut Locks on Track Bolts.

"The diagram represents the result of test beginning Sept. 8, 1892. There were twenty samples of each of fourteen kinds of nut locks placed in the track, and against these twenty bolts without nut locks and twenty with check nuts were tested. They were placed in the main track (Zanesville & Ohio Ry.), on tangent, 1 per cent. grade, the track having 56-lb. rails, 4-bolt angle bars, and ¾-in. bolts with hexagonal nut ¾ in. thick. The traffic was light, and the maximum engine weight, without tank, was 94,000 lbs. No switching was done over this track, which insured the same traffic over all the samples tested.

"The locks were placed, and nuts set up until they were pronounced tight. Then they were gone over again, and care taken to have each screwed up flush, except in the case of the Standard, where 20 per cent. 'set' was left, according to instructions from the manufacturer. After the test in the track was completed, the pull necessary to start the nut forward was measured, the pull being exerted on the end of a 5½-ft. wrench. The diagram shows the average for each kind. The results are simply for comparison. Effort was made to secure uniform conditions in all ways possible, in order to offset the fact that the number placed was limited.

"As is shown, the Verona and American Lock Washer No. 1 held all the bolts to which they were applied, with several other nut locks as close competitors. It is not claimed that it is a conclusive test. There are some conditions which cannot be made equal, such as differences in bolts and ties, though ties were of very fair quality, and bolts alike; yet it gives a general idea."

Metal Tie-Plates.

REPRESENTATIVES of the Goldie, the Servis, and the Churchwood tie-plates appeared before the Northwest Railway Club and debated upon the relative merits and defects of their several plates. The animated discussion brought to light a number of facts which the *Engineering News* (Sept. 12) has jotted down. These plates are intended to be placed between the steel rail and the wooden tie to prevent wear on the latter and at the same time to help hold the rail firmly. The article places the discussion under five heads, *viz.*, "(1) rib and flat top; (2) width of plate; (3) thickness of plate; (4) bottom ribs and teeth; (5) shimming."

The ribs are of two kinds, one along the edge of the rail to the outside, preventing outward movement, and the other at right angles to the rail, being recessed where the rail sets in place. The idea embodied by both is to prevent any lateral motion of the rail and wear upon the spikes.

But this precaution does not seem imperative, though many roads require it. The flat top plate seems to give as good results when the spikes are so driven as to prevent initial play. As to width of plates, "while one maker advocates narrow plates so as to concentrate the load near the middle of the tie and thus approximate to an ideal bearing narrow on top and wide at bottom, another maker claims that such plates increase the distance between the rail supports, thus reducing the stiffness of the track." The fact was brought out that wide plates, 6 in. or over, tend to produce rocking of the ties, and the suggestion was made that an increased number of narrow ties with narrow plates (3¾ in. wide) would be desirable. Thickness of the plates is determined by the strength necessary to resist buckling, as the wear is found to be small. Therefore a light plate stiffened by corrugations or ribs is as desirable as a plain thick plate. The corrugated plate shown was 3-16 in. thick, while the thick plates are made as much as ½ in. thick. "In respect to the method by which the plates are attached to the ties, the plates may be divided into two classes: first, those in which the projections are lengthwise with the tie and approximately parallel with the fibers; second, those in which the projections are transverse to the tie and cut across the fibers . . . It is certain that a tie plate must in some way be self-attached to the tie, so that it will not move under the traffic, but it appears doubtful whether any provision to prevent such a plate from moving lengthwise on the tie is necessary."

The sharp-edged grips or spikes seem to give best results, as they are less liable to displacement than the more obtuse projections on the underside of the plates. When the rail is raised by putting in liners under it, or "shimming," it is found better to leave the tie-plate in place and to put the shimming on top of it. "The tie-plate is intended to be a permanent part of the tie, and should never be removed to allow for the temporary expedient of shimming."

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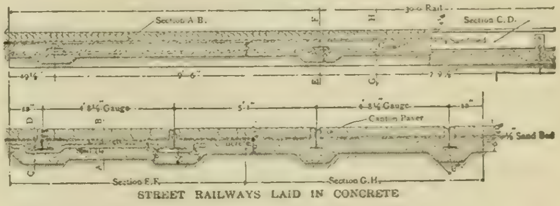
Street Railway Tracks Laid in Concrete.

One of the evils of the system of laying pipe, railway track, and underground wires in our streets is the necessity of tearing up the street and obstructing travel whenever repairs are necessary. The tendency toward improving this condition is shown in some new construction described in *The Railway Review* (Sept. 28).

"With a view of establishing a road bed which will require the minimum outlay for maintenance, the Detroit Citizens' Street Railway Company has adopted a construction for its tracks which seems to be the best and most durable which has yet come to our notice. The laying of track upon concrete, which is the method adopted in this case, has been tried in other cities, and has given satisfaction, especially in Montreal and Toronto. It is, therefore, not a new thing. The illustrations show the method adopted for the Jefferson and Gratiot avenue lines, in which it will be seen that the rail is of the girder type grooved and 9 in. high, the section being 100 lbs. to the yard. The track is held to gage by steel ties, which are from 4 to 5 ft. apart center to center; and, beside acting as tie-rods, these are supposed to assist in maintaining the surface of the track. It is doubtful, however, if they are necessary except in holding the track to gage, which fact seems to be recognized by the management, as it is proposed that some of the track shall be laid with ties spaced at 10-ft. centers.



STREET RAILWAYS LAID IN CONCRETE

"The sections show that the concrete comes against the flat base of the rail, the outline of the excavation being such as to bring the thickness of the foundation to a depth of 6 in. below every part of the rail and the tie. This applies also to the curved ties used on Gratiot avenue. Upon the top of the concrete a ½-in. sand bed is spread, which is surmounted by Canton pavers to be flush with the top of the rail. This pavement covers the space between the rails only, the paving of the remainder of the street being asphalt. The track on Jefferson avenue has electrically-welded joints, which constitutes an experiment the success of which will depend upon the ability of the contractors to dress down the joints to a smooth surface after the weld is made. A new feature in this welding consists of compressing the rails by hydraulic power before welding. The greatest troubles anticipated from the welded joints are the rough joints and the danger of breaking in winter. It is expected, however, that the compression method will overcome the breaking. The track in Detroit which has been laid in concrete is reported to be giving indications of success in every direction." As to the application of concrete to roads with higher requirements as to load carried, etc., the editorial quotes the views of a prominent steam railway engineer who has followed this track construction very closely. "There is no question about track laid on concrete being the proper thing for city streets. I believe that it is among the possibilities that track on concrete is the proper thing for steam roads. Its first cost would be somewhat more expensive than track laid on dirt or stone ballast, but I believe the maintenance expenses would be reduced sufficiently to more than offset the increased cost. Of course, such track for steam roads would be impracticable, unless the mills furnish straight rails. They have been a long way from doing this in the past, but have been making great improvements recently."

Managing Fuel and Water Supplies.

A VERY desirable feature is developing in the organization of workingmen's societies,—that of giving to the world their experience in the shape of papers and addresses. The Traveling Engineers' Association affords a good illustration of this tendency. At a recent meeting held in Pittsburg, Pa., among other valuable contributions a committee report was read upon the question: "Could not the locomotive service of the country be improved if the furnishing of feed-water and coal was in the hands of the locomotive department?" The committee secured information from a variety of sources, and, according to *The Railway Review* (Sept. 14), ascertained that "on English lines the locomotive fuel supply is under the control of the locomotive superintendent. The colliery companies send in tenders for a particular quantity of coal, and every wagon-load they send is examined by an inspector on behalf of the locomotive superintendent. Some of the various qualities of coal are carefully tested, both in practice and by the experts in the testing department; there is, therefore, no fear of any person supplying bad coal to the companies." Continuing: "Your committee would recommend that, from whatever source coal is furnished, the mechanical department should be consulted with reference to the quality, it frequently happening that a much better grade of coal can be procured at a very slight advance in price; and it should also be consulted with reference to the assigning of certain kinds of coal to certain districts, with a view of adapting all draft appliances within such districts to suit the coal furnished. With reference to the water supply, there seems to be considerable tendency on the part of those answering the circular to place the boiler water supply in the hands of the locomotive department. . . . Your committee believes that, in furnishing feed-water to boilers, the interests of railroad companies could be best conserved by having the handling of same in the mechanical department, or, at least, the head of the mechanical department should be consulted with reference to the quality of water furnished, and, where water is not suitable, means should be at hand for its betterment. One of the great losses entailed by railroad companies is caused by the use of bad feed-water, not only to the deterioration of the boilers, but also on account of loss of power, increased fuel consumption, and delay to traffic." The conclusion seems to be that, as the mechanical department designs, constructs, and repairs the locomotives, it should specify what fuel and water would produce the greatest result with the least wear.

THE RAILWAY GAZETTE for October says that the returns of gross earnings for the month of September, published last week by the *Chronicle*, show for 126 roads a gain of 4.57 per cent. over 1894. Certain unfavorable influences were acting during the month, among these a diminished cotton movement, a small wheat movement in the Central Western states, and, for railroads extending over a great area, thorough demoralization in rates. The spring wheat movement, however, has been very heavy, over 9 million bushels being delivered in Duluth in the four weeks as compared with a little over 4½ millions the year before. Almost 10 millions were delivered at Minneapolis as against about 8¼ millions the year before. The greatest increase in gross earnings is shown by the Great Northern, which amounts to over $417,000. Its September business was the largest in the history of the road. The Milwaukee & St. Paul shows an increase of about $273,000, and the New York Central $184,000.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Technical Journals—See Introductory.

1299. The Massachusetts Railroad Commission. William A. Crafts (Origin and growth of State supervision of railroads in the United States, exhibited chiefly by an account of the work of the Massachusetts commission). Eng Mag-Nov. 400 w.

*1329. Locomotives of the Great Eastern Railway, Past and Present. Ill. (Description with dimensions of locomotives used since 1845). Ry Wld-Sept. Serial. 1st part. 1200 w.

*1330. The Working Expenses of Electric and Cable Railways (A comparison, with 16 tabular statements, and items of expenses). Ry Wld-Sept. 1200 w.

*1331. Tramway Management (A rejoinder to "Tramway Manager" by a Tramway Official). Ry Wld-Sept. 1700 w.

1352. Comparative Merits of Metal Tie-Plates (Discussion by the makers, before the Northwest R. R. Club, of the comparative merits and faults of three forms of tie-plates. An excellent article). Eng News-Sept 12. 1900 w.

1357. Express Locomotives. John A. F. Aspinall (Part of a general paper read before the International Railway Congress. Interesting, broad and instructive). Eng News-Sept. 12. 4000 w.

1362. Some Underground Conduit Systems for Electric Roads. Ill. (A valuable summary of various devices which have been used). R R Gaz-Sept. 13. 2200 w.

1363. The Railroad Race from London to Aberdeen. J. Pearson Pattinson (A tabulated statement of time made between stations and also the world's record made by the West Coast route. Ill. of locomotives used). R R Gaz-Sept. 13. 1000 w.

1364. Some Weaknesses of State Railroad Management (Portion of a monograph on "Transportation" by R. van der Borght, with editorial). R R Gaz-Sept. 13. 1800 w.

1367. Continuous Rails on Steam Railroads. Walter Loring Webb (Considers it safe to use a rail 500 ft. long. Some interesting results of experiment and observation). R R Gaz-Sept. 13. 1600 w.

*1386. Street-Car Propulsion. W. A. Anthony (Considering the problem of obtaining a variable speed on the car from a constant-speed motor). Elec Eng, Lond-Sept. 6. 1500 w.

1390. Some Features of the Electric Power Plant of the Chicago City Railway Co. Ill. (Descriptive). Elec Ind-Sept. 1200 w.

*1411. A Year's Railway Accidents (Review of a Parliamentary paper showing that one passenger is killed in 7,789 000 journeys, and one in 789,000 is injured. The proportion of passengers injured in the United Kingdom was, in 1894 one in 2,626,000). Ry Times-Sept. 7. 1100 w.

1412. American and British Railways Compared (Giving tabulated statement comparing the various items of equipment, earnings and expenditure). Ry Age-Sept. 13. 400 w.

1436. The Madras Railway. Ill. Clement F. Street (Concise description of system, with nine half tone illustrations of the shops, station, engines and cars. The gauge is 5 ft. 6 in. Includes specifications of locomotives used). Ry Rev-Sept. 14. 800 w.

1437. Prevention of Black Smoke from Locomotives (An answer to the question "How Can the Traveling Engineer Assist in Preventing the Unnecessary Emission of Black Smoke." Report of Committee). Ry Rev-Sept. 14. 1000 w.

1439. Lessons from the English Races (Editorial comment on the results of making rapid time on the English railroads). Ry Rev-Sept. 14. 1500 w.

1440. The Traveling Engineers' Association Reports (An abstract of ideas presented at the meeting of the Traveling Engineers Association). Ry Rev-Sept. 14. 1200 w.

1441. Some Interesting Features of Interlocking. Ill. George H. Paine (An extended abstract of a paper read before the Engineers Club of Philadelphia in July). Ry Rev-Sept. 14. 2000 w.

1442. Best Methods of Managing Fuel and Water Supplies (Report of a Committee of the Traveling Eng. Asso. with reference to which department they should be under). Ry Rev-Sept. 14. 1600 w.

1445. The Gas Railway in Dessau. W. von Oechelhaeuser (Development of the Lührig System in Germany. A description with map and tables of costs and expenses. The motive power consists of seven and ten horse power gas-engines). Pro Age-Sept. 16. 6000 w.

*1451. Four-Wheeled Coupled Bogie Tank Engine. Ill. (Design for English passenger tank locomotive with complete dimensions and engraving of side elevation and inset drawing). Engng-Sept. 6. 500 w.

1460. Car Transfer Bridge at West Norfolk, Va., Atlantic and Danville R. R. Ill. (Detailed description of a hinged bridge for transferring railway cars from the pier to the barge or steamer). Eng News-Sept. 19. 1300 w.

1463. The Acceleration of the Speed of Express Trains (An editorial discussion of the probable effects of the recent railroad races in Great Britain and the American records lately made with the comparison of interesting data). Eng News-Sept. 19. 3800 w.

†1470. The British Railway to India (Editorial criticism upon a proposed railway through Persia). Ind Engng-Aug. 24. 1600 w.

1492. Position Signals for Night Use. J. W. Lattig (A device for intermittent lighting of railway signals). R R Gaz-Sept. 20. 1000 w.

1493. Tests on Cylinder Condensation of the Baldwin Compound Locomotive at Purdue University. Ill. R R Gaz-Sept. 20. 1400 w.

1496. Ventilation of Passenger Cars in Summer (Editorial comment upon inconvenience arising from open car windows at inappropriate times, with suggestions for improvements). R R Gaz-Sept. 20. 1700 w.

1497. Fast Time in England and America (Editorial. Comparison of time made by recent runs on English and American railroads). R R Gaz-Sept. 20. 1300 w.

1498. Care and Maintenance of Telegraph Lines (Editorial comment on railroad telegraph lines). R R Gaz-Sept. 20. 1200 w.

1499 The Greatest of Railway Runs—436½ miles in 407 minutes (A graphic description from *N. Y. Sun* with time made). Ry Age-Sept. 20. 2500 w.

1500. Notable Meeting of the Western Railway Club (Remarks upon the International Railway Congress by Colonel Haines, and response to a toast. The passenger department by Mr. Heafford). Ry Age-Sept. 20. 4000 w.

*1507. Railway Accidents and the Lessons They Teach (Editorial comment on the report of the Board of Trade, giving statistics). Trans-Sept. 13. 1500 w.

*1508. The Galway and Clifden Railway (General description of a projected West Ireland Railway. Map and four half-tone views of scenery). Engng-Sept. 13. Serial. 1st part. 2000 w.

*1523. The Snaefell Mountain Railway. Ill. (A pleasure line, interesting on account of the rapidity which has marked its construction, and because it is the first time electricity has been used in the British Isles on such heavy grades). Elec Rev, Lond-Sept. 13. 2800 w.

1528.—$1. The Substitution of Electricity for Steam in Railway Practice. Louis Duncan (A consideration of electric traction as it stands at present. Discussion). Tr Am Inst of Elec Eng-June & July. 10000 w.

1543. New Car Shops at Burnside—Illinois Central Railroad. Ill. (Description of these shops, twelve miles from Chicago, with map, plans and detail cuts). Ry Rev-Sept. 21. 2500 w.

1545. Filling with Sluiced Material. Ill. (The filling in of trestle bridges on the N. P. R. R. making permanent embankments). Ry Rev-Sept. 21. 600 w.

1554. Montreal Street Railways. Ill. (Descriptive). Elec Ry Gaz-Sept. 14. 2300 w.

*1558. The Isle of Man Electric Tramways. Ill. (Snaefell electric tramway. Description. The Douglas-Loxey). Elect'n-Sept. 13. 4000 w.

*1561. The Subject of Light Railways as an Assistance to Agriculture. C. E. Webber (Paper read in Section G of Brit. Asso. at Ipswich). Elec Eng, Lond-Sept. 13. 8000 w.

1569. How Shall We Heat Cars? J. F. McElroy (Abstract of a paper read before the St. Ry. Asso. of the State of N. Y. General principles involved in the construction and operation of electric heaters, etc). Elec Eng-Sept. 25. 2300 w.

1573. General Track Construction. C. Loomis Allen (Read at N. Y. State St. Ry. Con. A progressive description of the best methods in use). Elec Ry Gaz-Sept. 21. 2000 w.

1597. Freight and Mail Traffic on Street Railways. Benjamin Norton (Interesting details showing how it is made to pay). Eng News-Sept. 26. 1100 w.

*1598. Operating an Electric Road on a 25½% Grade. Ill. (An endless cable device, the ascending and descending cars balancing each other, with four cuts of designs and details). St Ry Rev-Sept. 15. 2000 w.

*1600. Dey-Griswold Hydraulic Gear. Ill. (The substitution of oil under pressure from pumps with variable stroke, acting on motors, for gears). St Ry Rev-Sept. 15. 600 w.

1616. Railroading Over an Earthquake. Ill. Cy. Warman (An American engine-driver's strange experience on an engine in Europe). McClure's Mag-Oct. 2500 w.

1617. The Traveling Engineers' Association (An abstract of the proceedings with a lengthy article on air-braking). R R Gaz-Sept. 27. 4000 w.

1618. Standard "Front End" of Car Adopted by the New Haven Railroad Ill. (Short reference with two sections illustrating the construction). R R Gaz-Sept. 27. 200 w.

1622. Passenger Station of the Eastern Railroad at Paris, France. Ill. (Description with map showing system of tracks). R R Gaz-Sept. 27. 700 w.

*1642. The Railways of the United Kingdom (An editorial on the financial condition of English Railways). Trans-Sept. 20. 2800 w.

*1643. Breaking the Train Speed Record. Ill. A. S. (Description of trip on the N. Y. C. & H. R. R. on the occasion of making the world's record). Loc Engng-Oct. 2500 w.

*1644. More Facts About the British Train Racing. Ill. (Details of the recent British fast runs, with six half-tone illustrations of the types of racing engines). Loc Engng-Oct. 1100 w.

*1645. Six-wheeled Truck. Ill. (Details with drawings of truck used on the B. & O. R. R.) Loc Engng-Oct. 600 w.

*1646. Strengthening of Ends of Passenger-Train Cars (Drawings with description of some new designs by the B. & O. R. R). Loc Engng-Oct. 1200 w.

*1647. Railway Capital, Revenue, and Traffic, 1894 (Abstracts from the Board of Trade return on English railways). Ry Times-Sept. 21. 7800 w.

1652. A New Conduit Railway System. Ill. (A system which possesses several points of novelty. The invention of John La Burt). Elec Ry Gaz-Sept. 28. 700 w.

*1659. A Large Railway Ferry Steamer. Ill. (A boat conveying cars across the Volga. Length 252 ft., carrying 24 trucks). Eng, Lond-Sept. 20. 1200 w.

*1660. Express Locomotive, North-Eastern Railway. Ill. (Showing relation between track and stack draught and arrangement of exhaust used). Eng, Lond-Sept. 20. 400 w.

1672. A Melan Arch Railway Bridge. Ill. (Details of a re-enforced concrete arch, eight track bridge). Eng Rec-Sept. 28. 900 w.

1695. Street Railway Tracks Laid in Concrete. Ill. (An excellent system of track construction with steel ties 5 ft. apart, supporting 100 lb. rails, all embedded in concrete and topped by Canton pavers). Ry Rev-Sept. 28. 500 w.

1696. The Glasgow District Subway. Ill. Angus Matheson Stewart (Sections of tunnel for an underground passenger railway 6½ miles long, containing two tracks, operated by cable). Ry Rev-Sept. 28. 2800 w.

1697. Fast Freight Lines and Their Evils (Editorial advocating discontinuance of through freights). Ry Rev-Sept. 28. 900 w.

*1708. A Narrow Gauge Electric Locomotive. Ill. R. W. Weekes (Built by Easton, Anderson and Golden for the 18 in. line between the electrical school at St. Mary's Barracks, Chatham, through the dockyard, into the submarine mining establishment at Gillingham. Descriptive). Elec Eng, Lond-Sept. 20. 1800 w.

†1741. Consular Report on the Tramway System of Paris and the Department of the Seine, France (An exhaustive report, giving the history, decrees, concessions, etc. in the development of this French railway system). Ind & East Eng-Aug. 31. Serial. 1st part. 1800 w.

†1758. The Electric Railway System of Niagara Falls. Ill. (Description of the power plant, equipment, construction and operation of several electric car lines in and about Niagara Falls). St Ry Jour-Oct. 6800 w.

†1759. Some Notes on the Manufacture of Car Wheels (A treatise on the effect of chilling upon cast iron wheels, with three half-tone illustrations of effects shown by fractures). St Ry Jour-Oct. 2000 w.

*1760. Lead for Locomotives. C. A. Seley (Discussing the effect of too much lead as shown in railroad locomotive practice. Illustrated by indicator cards). Nat Car & Loc Build-Oct. 2000 w.

1780. Combined Motor and Baggage Car for Suburban Roads. Ill. (Description of cars used on the Nantasket branch and other electrical roads). W Elec-Oct. 5. 800 w.

1790. The Comparative Efficiency of Track-bolt Nut Locks (The results of tests on 14 kinds of nut locks, with diagram). Eng News-Oct. 3. 500 w.

1791. Railway Track and Maintenance (Abstracts of committee reports presented at the meeting of the New England Road-master's Asso., on tools, spikes. bolts, braces, tie-plates, &c., with recommendations). Eng News-Oct. 3. 1400 w.

1800. The Need of Care in Selecting the Source of Water Supply for Locomotives (Extract from a letter to the Traveling Engineers Asso. Suggestions worthy the consideration of roads that have done little to improve their water supply). Ry Mas Mech-Oct. 900 w.

1801. Compound Locomotive Test on C. & N. W. Ry. Storm Bull (From a paper read before the W. Ry. Club. Tests conducted and thesis written by Messrs. Hartwell, Hansom and Meyer, seniors in mechanical engineering at the Univ. of Wis). Ry Mas Mech-Oct. 2000 w.

*1833. Brake Trials on the North-Eastern Railway (Description of tests with diagrams representing results on a Westinghouse quick acting brake, relative to its application to ordinary brakes now in service). Eng, Lond-Sept. 27. 3000 w.

1844. The South Orange and Maplewood Railway. Ill. (The notable features of the work are the solid construction of the road and the excellence of the material used. Every effort has been made to make the road as nearly perfect as possible. Descriptive with notice of interesting features). Elec Ry Gaz-Oct. 5. 1000 w.

1860. The proposed Jungfrau Electric Railroad. Ill. V. M. Berthold (A short abstract from the latest available information. The road when finished will be the highest railroad of the world). Elec Rev-Oct. 9. 1000 w.

SCIENTIFIC MISCELLANY

Fighting Forest Fires.

A WRITER in *The Forester* for September says that a potent reason for forest fires, such as occurred in the vicinity of Shemong and Reed's crossing in July, 1894, is the want of any special organization for preventing and combatting them. When these fires approach and threaten the homes of residents, the people imperilled will make efforts to turn the course of the conflagration for self-protection; otherwise, the fires go on till they burn themselves out or are extinguished by an opportune rainfall.

The writer gives a very interesting narrative of the forest fire above mentioned, and of the feeble, disconnected efforts that were made to arrest its progress. "The fire was very disastrous." The author of the article, Mr. Price of Tuckerton, "was an active participant in its extinguishment." It extended over an area of 175,000 acres, converting the tract burned over into a veritable desert. Though its origin was 20 miles away from Tuckerton, it seriously threatened Tuckerton before it ended. But, passing further details of the progress of the fire, we will let Mr. Price tell the story of the efforts put forth to save Tuckerton.

"On the Friday the fire raged across the country I rode out into the woods to investigate. The main body of flames had swept by upon Stafford Forge and Manahawken, but the long flank was left,—mile after mile of fire backing down toward Tuckerton. A northwest wind would, therefore, bring us instant and most alarming peril. An attempt was made to rally a fighting force, a harnessed team going at evening into the village, and the danger and opportunity being both presented. The men acknowledged the truth of all that was said, but firmly took the stand that they ought to be paid.

"Are they not right? They do not own a foot of forest. The owners are capitalists living in New York, Philadelphia, and other States and cities. Why should boatmen and laborers spend a night in severe and dangerous toil without compensation, fighting for absent owners? And again: why should absent owners pay men to fight fire when they go out in an undisciplined mob, under impromptu leadership, and when it is often too late to save the property? And again: who shall telegraph the owners and get them to act?

"If any one thinks townships can act, I reply, this fire burned property in at least eight townships. For them to act as townships would be a wasteful and confusing policy. If the State acts by means of large districts, we shall have unity. This fire could have been put out a dozen times by a small State force, paid, officered, disciplined, and known to have authority. The State taxes forest property and also the exposed towns. Does it not owe them protection? One cent per acre annually, under wise organizations, ought to pay the cost.

"But Tuckerton was not rid of her fire. Nature has encompassed her with bays and rivers, and a merciful Providence held the wind continuously in a quarter from the sea. Still the fire slowly enclosed her. Alive to the folly of sitting still, another effort was determined upon. Knowing two good men who were willing to fight, it was decided to go out with these alone, if necessary, but there were hopes that the example would have inspiration. So it proved. We started one evening at 6 o'clock, and by 9 had fifteen or twenty men. Three or four miles of fire were subdued, and, when we returned, wearied, at 3 o'clock in the morning, it was expected a fresh force would finish the arduous battle. But the fresh crew never came, and the mile of fire left burning 48 hours undid the work accomplished.

"Another proof of the need of the organization. Other days pass, and again one afternoon the smoke arises black and near. I hasten forth to find a Jew in the outskirts has been seized with a panic, and has set a fire nearer, hotter, and more dangerous than the one that frightened him. The new fire sweeps wildly before the wind, whereas the old fire had to burn against the wind. Fifty men sit looking on. Two things are evident. One is that nineteen-twentieths of the people are mere spectators. The other is that a section gang sent by the railroad, being paid for their time, expect to work. These men go into the line of fire, but the task before us is hopeless unless we can find a strategic point from which to fight. Fortunately it is found at last, just in the nick of time, and by hard work and back-firing we gain the day.

"This fire, so narrowly brought under control, ought to have been watched, but, with no system, who is to do the watching?

"In a few days there is peril again, with the enemy at still closer quarters. Two bodies of men go out and begin work by direct assault on each extremity of the fire. They are perhaps a mile apart. The thermometer in the woods is above 100 deg., and the flames are like a furnace. The men lie down again and again from exhaustion. There is no drinking water. The woods are a tangled thicket of undergrowth and briars. No tidings come from one company of men to the other. No one knows whether the fight is maintained elsewhere, or how large a body of fire remains to conquer. Discouragement appears. Then a volunteer on one company undertakes to determine the situation. He finds two-thirds of the fire put out; the other company of men completely discouraged and on their way home; a plucky worker fighting single-handed in the middle of the line of fire, though ignorant of other helpers.

"A knowledge of the situation cheers every one, and all return to work with a will. Drinking water is brought by a team, and in a brief space the battle is over. Many lessons appear, but they sum up in this: there must be organization, and it is especially desirable to have good leadership. Everybody's business is nobody's business."

Anomalies in Sanitation.

THE basis upon which the whole structure of sanitary engineering rests is the proposition that zymotic diseases can be prevented. If this proposition be broadly true, the reason for the existence of sanitary rules and appliances, and for knowledge and skill in their application, is obvious; if not true, the belief (expressed by some) that much of what is taught and insisted upon by sanitarians is humbug, and much which is done by sanitary engineers is an expensive concession to pseudo-science, is well-founded. Those who entertain this belief are wont to clinch their arguments with the question: "if disease can be prevented, why, notwithstanding the adoption of all these rules and appliances, does not the class of diseases to the prevention of which they are specially framed and directed disappear from civilized communities?" This question *The Sanitary Record* (Sept. 6) meets with a complete answer, which is that "both individuals and communities still continue to preach without practising the things which are now generally admitted to be essential to healthy life." As one example of the truth of this statement the following is quoted:

"Only recently it was the writer's pleasure and privilege to spend a portion of his holidays in the Hartz mountains,—the Oberland of Germany, in the province of Brunswick, where Dame Nature has been profusely generous in her distribution of beauty. The district, while comparatively unknown to, and far from the beaten track of, the British tourists, is, by reason of its being the only part of Northern Germany deserving of the name of mountainous, dearly beloved by the denizens of 'Vaterland'; and hither a yearly increasing flock of them wend their way, doubtless with benefit to nearly every one concerned. Provision in abundance for this annual influx is to be found in the way of conveyance and of accommodation, the hotels, pensions, gasthauss, and cafés vieing with each other in their amplitude of attraction and comfort. So far, so good, and, to the mind of the Guelph, an earthly paradise.

"Midst of all this wealth of natural

beauty and catering for popular patronage, and in a country so deservedly famed for its research, investigation, and discoveries in the deeper realms of the science of hygiene and sanitation, it might reasonably be expected that some little attention would here be paid to the ascertained elements of those subjects, but what a rude awakening the assumption receives!

"Down as pretty a valley as the eye could see or the mind can conceive, there winds its way through a charming village a mountain streamlet, innocent at its rise of the near presence of a civilized community. As we approach it and the village from the lower side, an odor more pronounced than pleasant is perceived, and a friend suggests the proximity of a pig cote. A second thinks it probable that a middenstead is being disturbed, while a third makes a deviation, and solves the query by finding a sewage-bearing brook, which, on further investigation, proves to be at once the sewer for the district and a continuation of the aforesaid virgin streamlet?

"It would probably be argued by those who are responsible for such a condition of affairs, should there be any such, that, if it is a danger at all, its potency for evil is reduced to a minimum by the open nature of its surroundings, and that the volume of pure spring water which is constantly flowing through the channel suffices for all practical purposes to keep it clean and sweet. This, however, is an argument that has often been exploded; and to those who are cognizant of typhoid fever at Lausanne in Switzerland some years ago, when the calamitous, and at first incomprehensible, appearance of the disease was ultimately traced to the pollution by sewage of the village stream some 2 or 3 miles from the site of the outbreak, the contention would, if advanced, be rejected with scorn."

The internal arrangement of sanitary appliances in the region named are also very objectionable, as was found on investigation, although external cleanliness appears to prevail to a marked degree; and these arrangements indicate a wide-spread ignorance of facts and principles.

Process for Preserving Fresh Fruit.

A PROCESS stated to be new by Mr. Henry P. du Bellet, United States consul at Rheims, is so simple that it appears worthy of a good trial. It has the merit, also, of cheapness. An account of this process is contained in *Consular Reports* for September.

Impressed with the powerful action of alcoholic vapors on the mold which generally appears on the surface of fruits in a damp atmosphere, Mr. Petit noticed that pears and apples kept for several months in a surrounding atmosphere saturated with vapors of water and alcohol, even were they at the beginning in a state of decay, showed no signs of mold, while fruits in every particular similar to the former, stored under the same conditions, but not exposed to the action of alcoholic vapors, were entirely covered with it.

Taking advantage of this observation, Mr. Petit applied the principle to the preservation of fruits in general, and most particularly to grapes, because more than others these are subject to mold. It was to be foreseen that grapes kept from the day they are cut off the vines in an atmosphere saturated with vapors of water and alcohol would, by the retarding of the sweating period, not only remain free from mold, but even retain their natural aspect. Consequently, should the temperature be constant and low, the preservation could be maintained long and well.

"On the 31st of October, 1894,—that is, very late in the season and at a very unfavorable time,—Mr. Petit placed, with other fruits, and a bottle containing 61 cu. in. of alcohol at 96°, some bunches of grapes known as 'Chasselas de Fontainebleau,' fresh from the vine, in a brick recipient in the form of a parallelopiped, cemented inside and closed as hermetically as possible by a common wooden door. In two similar recipients contiguous to the first, one of which was kept open and the other closed, but without alcohol, were stored similar fruits from the same trees and vines. The fruits were laid on wood shavings. The recipients were built in a very damp cellar, temperature of which varied regularly from 50° to 46.4° F. during the whole time the experiment lasted.

"On November 20 the grapes placed in the recipient left open, and especially so those in the closed recipient without alcohol, were mostly rotten and covered with mold. In the recipient containing the bottle of alcohol the grapes were beautiful; on one bunch two grapes had turned brown, but they were firm, full, and free of mold; they did not taste at all sour, thus differing essentially from moldy grapes, especially those subject to *Penicillium glaucum.* A hair hygrometer in the recipient registered 98°. On December 7 the bunches of grapes in the recipient containing the alcohol had kept their fine aspect; on most of them, however, one or two grapes had turned brown, and were in the same condition as those above referred to. On December 24 same results; on most of the bunches could be seen one or two grapes commencing to decay. At the end of nearly 2 months each bunch had lost but from two to four grapes, and all were in a perfect state of preservation, the stalks being perfectly green and the grapes firm, full, and savory, and having all the qualities of fresh cut grapes.

"At the conclusion of the experiment, 17 cu. in. of alcohol at 60° remained in the bottle out of the 61 cu. in., but, as Mr. Petit remarks, the door of his recipient had not been built with great care and did not close hermetically; hence a useless consumption of alcohol."

"This process, if further trial prove its efficiency, offers many advantages. It is simple, easy of application, and cheap, and, if adopted by our fruit growers, would allow them not only to hold their fine fruits until they can dispose of them at a fair price, but would also insure them handsome profits during the winter months."

Industrial Value of Ramie Fiber.

For a long time the attention of manufacturers, scientific men, and inventors has been directed toward the utilization of the ramie fiber, and such progress has been made, notwithstanding mechanical difficulties in working it, that it now bids fair to figure extensively in the list of textile materials. The Boston *Journal of Commerce* (Sept. 14) gives, editorially, a pretty good showing of progress in the utilization of this fiber, and states some interesting facts.

The sails of the yacht Defender were of this material, the yarn, imported from England, having been woven into duck cloth at the mill of the Lowell Weaving Co. The superintendent of this company is reported to have said that "it is the best material ever used for duck," as it neither stretches or shrinks when subjected to moisture and is "30 per cent. stronger than Sea Island cotton. The sails of the Valkyrie were also of ramie duck."

Our contemporary announces that there is a new mill at Cranston, R. I., devoted to the manufacture of ramie, and thinks that in this mill the industry will be developed farther than hitherto, although the number and extent of the uses to which the fiber has been put already will be new to many people. "For goods usually made of linen, ramie is said to be particularly applicable on account of its great resistance, both with regard to washing and to wear. The most important hotels and railroad companies in France have, it is stated, entirely adopted the use of ramie, and it is also asserted that the city of Paris has adopted this linen for the service of its twenty arrondissements, and that it has been ordered for the dressing of wounds in several hospitals, including those for the army and navy. It is said that the minister of war employs it for the cordage of balloons, powder sacks, etc.; that the Bank of France now uses nothing else for the manufacture of its notes but the ramie supplied by the Valobre factory, and that it finds the new bank note of ramie to be finer, more durable, and capable of receiving a better impression, consequently rendering forgery of notes much more difficult, if not impossible.

"The possibilities of the ramie fiber in manufacture seem to be unlimited, such as its use in stuff goods for men's wear, upholstery, curtain laces and embroideries, plushes and velvets, stockings, underclothing, table damasks, napkins, handkerchiefs, shirtings, sheetings, sail ducks, carpets, cordage, fishing nets, and yarns and threads for various uses. The facility with which ramie may be made to imitate all other textiles is said to be one of the principal causes which has kept back the development of the industry, and it is thought that if, instead of launching out into a series of experiments, attention had been concentrated upon the exclusive manufacture of those articles to which the properties of the plant were peculiarly and naturally adapted, the industry would probably be in a more advanced condition than it is at present."

Some fine exhibits of ramie fiber, degummed by the Forbes process and by Jones and Warr, were shown at the late World's Fair in Chicago. Another process of degumming that has given excellent results is known as the "Boyle" process. The cultivation of ramie is, at present, as it has been in the past, engaging much attention in the United States agricultural department, with encouraging results. It is believed that it has a great future.

The Future Rubber Supply.

It having been proposed about a quarter of a century ago to enter upon the artificial cultivation of plants and trees yielding caoutchouc in view of the supposed likelihood that the demand would outgrow the supply, and some attempts at such culture having been made, this "new departure in economic botany" is discussed in *Engineering* (Aug. 30), its results having been "satisfactory as far as the possibilities of growth are concerned," although the cultivation of rubber plants "has not yet entered into serious competition with the rubber supply from untended nature."

The tone of the American technical press, *Engineering* thinks, would seem to imply that, although it has been demonstrated that rubber plants of different species may be artificially cultivated, the effort has been misdirected, and the "time and trouble" devoted to it have been "expended needlessly." The reasons assigned for this opinion are, in brief, that, while the demand for rubber has constantly increased, the price has not materially varied, indicating that the supposition of a possible early dearth of rubber, entertained at the time the experiments in artificial culture were initiated, was erroneous.

The experiments made are, notwithstanding, justified on the grounds that, at the date mentioned, there was a strong probability that a demand increasing more rapidly than the supply would enhance the price, and that many now known sources of supply were at that date unknown to the world.

"The common facts of to-day were not the common facts of 10 or 20 years ago. . . . . The discovery of these rubber forests is of recent date, and it cannot, therefore, be pointed at as an overlooked factor in the original consideration of the matter. It will be remembered by those interested that the representations made to our Kew authorities as to the depletion of the rubber forests were couched in distinctly alarmist language, and therefore they quite merited the measures taken by the India office. Of course it was possible for our government to have undertaken such explorations as have recently been made by private individuals, and this would probably have resulted in the alarmist rumors being somewhat discounted, as we may presume that the forests of to-day existed in much the same condition 20 or 30 years ago. However, it is easy to be wise after the event, and we shall certainly not be found in the ranks of those who seek to throw ridicule on the whole movement, because, whether the expense and trouble which our Kew authorities have been put to seem warranted or not at the present time, it has certainly been shown that rubber trees can be successfully acclimatized and grown in India and other districts far remote from their original habitat, and occasion may yet arise when the information thus gained may prove of much value to the india-rubber industry."

Critical Temperature and Boiling Temperature of Hydrogen.

When a gas, under sufficient pressure and cooled very nearly to the temperature at which it will liquefy under that pressure, has its pressure slowly diminished, its performance of work through its own expansion during the reduction of pressure lowers its temperature to the liquefaction point, and, liquid forming throughout the mass, a temporary turbidity indicates the fact. The pressure at which this phenomenon takes place is called the "critical pressure." The temperature at which it occurs is call the "critical temperature," the phenomenon of liquefaction under the conditions named being in the nature of a crisis.

Upon this principle Professor K. Oloszewski, of the University of Cracow, founded his method of determining the critical pressures of gases. He now has communicated to *The Engineering and Mining Journal* (Sept. 21) an account of the method (which he calls "the method of expansion") of the determination of the critical and boiling temperatures, the critical temperature being that at which the above-mentioned turbidity occurs, and the boiling temperature being that at which the liquefied gas assumes the gaseous form again, under reduction of pressure. Applying this extension of the method to the determination of these data for hydrogen, he finds its critical temperature to be —234.5° C., and its boiling temperature to be —243.5° C., the difference being 9° C. That is to say, the temperature it assumes while changing its state from liquid to gaseous is 9° lower than that at which it begins to liquefy enough to show turbidity.

The paper is of great scientific and practical interest. It is on the alternate assumption of the liquid and gaseous forms by gases that the action of most modern ice-machines depends, and this class of machines is among the most notable engineering triumphs of the present century. The paper is too abstruse for the non-technical reader, but will be exceedingly interesting and instructive to scientists and engineers. The determination of these low temperatures is made by the use of platinum thermometers. As these are unfamiliar to most readers, it is proper to explain that they are instruments which give inferential indications of temperature through the variations of electrical resistance at different temperatures in a standard platinum conductor. A description of both apparatus and method is comprised in Prof. Oloszewski's communication.

Professor Natanson has confirmed the validity of Professor Olszewski's experiments and results by showing that they correspond with conclusions reached by thermodynamic methods.

THE pearl shell fishery, in West Australia, produces, annually, shell to the value of $500,000 to say nothing of the pearls gathered in addition. Large sums are expended on the pearling fleet and in keeping up the stations. Over one thousand men are employed in the trade. The artificial cultivation of the pearl shell oyster is now being essayed, but it is yet too early to determine with what results. Nearly all of the produce of the industry goes to England. Before shipment the shell is taken to one of the shore stations, weighed, packed, and is then placed on board.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Technical Journals—See Introductory.

1311. Cost of Steam and Water Power in Montana M. S. Parker (The author bases his comparisons of cost upon data collected during five years attention to the subject, and presents results in tabulated form, in a paper read before the Montana Soc. of Civ. Eng. He finds the available water power of Montana enormous). W Min Wld-Sept. 7. 1200 w.

1335. Long Range Rifle Practice. A. G. Holcombe (Description of targets, with horizontal and vertical lines to measure accurately the range and wind gauge). Sci Am Sup-Sept. 14 1000 w.

*1348. Color Influence (The effect of color in mural decoration, etc., upon the nervous system of occupants of rooms so decorated. Some curious instances related). Plumb & Dec-Sept. 2. 1200 w.

1373. The Roman Frontier System. Prof. Pelham (History and leading features). Arch & Build-Sept. 14. 3500 w.

1410. Ramie and the Defender's Suit of

Sails (Editorial. The industrial possibilities of ramie fiber. An interesting article). Bos Jour of Com–Sept. 14. 1000 w.

*1414. Anomalies in Sanitation (Editorial. Sins of omission and commission. Examples). San Rec–Sept. 6. 1000 w.

*1426. The United States Naval Proving Ground at Indian Head (A description of the testing ground and appliances used in the trials of guns, armor, projectiles and explosives purchased by the United States government). Eng, Lond–Sept. 6. 4000 w.

1457. Georgia Marble (The extent of the deposit, its characteristics and value). Tradesman–Sept. 15. 1100 w.

*1487. Address to the Mechanical Science Section delivered by Mr. L. F. Vernon Harcourt, President of the Section (Discusses the relation of engineering to science. Mathematics, physics, chemistry, geology and meteorology in relation to engineering ; failures of works due to neglect of scientific considerations ; engineering specification, etc.). Eng, Lond–Sept. 13. 7000 w.

1488 The Exploration of the Surface of the Globe. J. Logan Lobley, in *Knowledge* (Takes the ground that the field for geographical exploration is yet wide, and points out where such exploration may be profitably directed). Sci Am Sup–Sept. 21. 1600 w.

1494. The Exhibition at Atlanta. Ill. (General description and comments). R R Gaz–Sept. 20. 3800 w.

1501. Determination of the Critical and the Boiling Temperature of Hydrogen. K. Olszewski (An application of the " expansion method " of determining the critical pressure of gases devised by the author, to the particular gas, hydrogen, for determination of the data named. Apparatus and method described. The critical temperature is thus fixed at—234.5, and—243.5 as the boiling temperature). Eng & Min Jour–Sept. 21. 2500 w.

*1542 The Rare Earths Used in the Mantles for Incandescent Lighting (Treats chiefly of thorium, its sources, and the character of minerals containing it, with hints for the commercial valuation of thorium nitrate). Jour Gas Lgt–Sept. 10. 2400 w.

*1548. Development of Carriages on Common Roads. John Philipson (Presidential address to the British Inst. of Carriage Manufacturers. A retrospect of progress in road vehicles, including two centuries). Prac Eng–Sept. 13. 3200 w.

*1570. The Relation of Science to Industry. N. S. Shaler (Consideration of the preparation which should be given to youths in order to make them fit to do their part in the industrial life of the time). Chau–Oct. Series. 1st paper. 3800 w.

1580. New Process for Keeping Fruit Fresh. Henry P. du Bellet (The fruits are kept in a moist atmosphere impregnated with alcohol vapor. Directions for carrying out the process are given and results stated). Consular Rep–Sept. 1000 w.

1581. A New German Lamp. Charles de Kay (A lamp wherein a chemically changed alcoholic spirit, volatilizing at low temperature, is burned, and an incandescent mantle gives the light). Consular Rep–Sept. 600 w.

1625. Facts about Trichina Spiralis, the Pork Parasite. Ill. (Facts and figures obtained at government inspection stations at Chicago, Milwaukee, Omaha, Kansas City and Boston during four years experience of the author in charge of the work. A valuable monograph). Sci Am Sup-Sept. 28. 1800 w.

*1639. Well-Meant but Futile Endowments: The Remedy. Charles F. Thwing (A review of endowments to colleges, universities, charities, etc., setting forth some of the causes that retard the good work intended, and drawing conclusions. The author thinks it undoubted that the cause of higher education represents the best object for the bestowal of general benevolence). Forum-Oct. 1400 w.

*1641. Higher Pay and a Better Training for Teachers. Jno. Gilmer Speed (An alleged deficiency in the qualifications of teachers for our public schools is attributed to want of a real appreciation of the value of education on the part of the American public ; to want of proper qualification on the part of school trustees and members of boards of education, who employ the teachers ; and, more than all, to the small remuneration of teachers for their services, which fails to attract the best talent into the profession of teaching. The remedy is suggested in the title). Forum-Oct. 4000 w.

*1683. A New Smokeless Powder (Editorial discussion of the remarkable properties of the Maxim-Schupphaus gunpowder, describing its composition and form ; the effect upon projectiles being largely due to this form). Engng–Sept. 20. 1600 w.

*1684. An Improved Portable Photometer. Ill. W. H. Preece and A. P. Trotter (Paper read before section G, of Brit. Asso. A new photometer in which the Bunsen screen is replaced by a pierced diaphragm of white cardboard, and which comprises other innovations also). Engng–Sept. 20. 2500 w.

†1693. An Account of the Gardiner Lyceum, the First Trade School Established in the United States. John H. Cooper (This school was incorporated by an act passed Jan. 30, 1822. It is believed to be the very first school in the nature of a trade school ever founded in the United States. The account of this school is compiled from printed and written records possessed by George M. Holmes, of Gardiner, Me). Jour Fr Inst-Oct. 6000 w.

*1699. Production of Graphite from Carbon. Ill. (Describes the artificial production of graphite in the electric furnace with details. A very interesting, scientific article). Ind & Ir–Sept. 20. 2000 w.

†1725. Birds in Flight and the Flying Machine. Hiram S. Maxim (A study of bird motions, with brief reference to experiments made with flying machines). N Am Rev-Oct. 2800 w.

1750. Some High Mountain Observatories. Ill. Edward Whymper (Popular description of high altitude observatories in Europe and America. A very interesting paper. Reprinted from *Leisure Hour*). Sci Am Sup-Oct. 5. 6000 w.

†1751. Trout Culture. Ill. Fred Mather (A well illustrated, practical treatise giving details necessary to success and noting causes of failure). Pop Sci M-Oct. 4800 w.

1753.—$1.50. The Temperature of Lakes. Desmond FitzGerald, with Discussion (An account of an important series of very difficult observations of temperature of lake-water at different depths, the interesting results of which are indicated graphically and also in tabulated form). Trans Am Soc of Civ Eng-Aug. 6500 w.

*1755. London by Night (Interesting popular description of the illumination of London in different parts of the city, which like the play of Hamlet with Hamlet left out, makes little or no mention of electric lighting, of which London certainly has some). Jour Gas Lgt-Sept. 24. 2000 w.

*1767. Trade Catalogues (Editorial. Treats of the shortcomings of this class of literature and seeks for a cause, which it finds in the lack of what Herbert Spencer calls constructive imagination and power of expression). Am Eng & R R Jour-Oct. 1500 w.

*1769. Aeroplane Stability During Flight. Ill. William Kress (Treats first of mechanical flight in calm air, and second, of a method by which an æroplane can be maintained in equilibrium during gusts of wind. A well written and learned dissertation. Describes also experiments made by the author). Am Eng & R R Jour-Oct. 4000 w.

*1811. Principles of Invention. Edward P. Thompson (Reversal in invention considered, and the importance of its systematic application to all inventions emphasized). Elec Pow-Oct. 3000 w.

*1814. Commercial Fibres. D. Morris (This first of the series of Cantor lectures the extent of commerce in fibres; essential element in fibres, fibre-bundles, and cells; raw fibrous materials; botanical and chemical investigations of seed hairs; cotton; kapok and vegetable silks, leaving the discussion of latter topic to be completed in future lecture). Jour Soc of Arts-Sept. 27. 6000 w.

*1815. Cedar and Cork Forests of Algeria (Review of two brochures issued by the Algerian government for the purpose of drawing attention to the forests of the colony). Jour Soc of Arts-Sept. 27. 1200 w.

1816. Making Postage Stamps. How the Work is done in the Bureau of Engraving and Printing (Copied from the *Baltimore American*. An interesting, popular description of the business and processes of making U. S. postage stamps). Bos Jour of Com-Oct. 5. 1500 w.

*1818. The Superiority of Winter Wheat Flours. William Welsh (a paper read at the Penna. Miller's State Asso. An argument to prove that while spring wheat flour makes more loaves for a given weight than winter wheat, the latter makes better bread). Am Miller-Oct. 1. 1400 w.

*1821. The Visibility of Change in the Moon H. G. Wells (The author tries to show that there is ground for denying that the moon is indeed an immutable dead world beyond change). Knowledge-Oct. 1300 w.

*1822. The Voyage of H. M. S. "Challenger" and Its Achievements. H. N. Dickson (A brief account of the scientific researches of an expedition sent out in 1872 to examine the sea from surface to bottom). Knowledge-Oct. 3000 w.

*1841. On the Constituents of the Gas in Cleveite. C. Runge and F. Paschen (The gas believed to consist of two, and not more than two, constituents. One helium, the other ought to receive a new name. Conclusion confirmed by experiment). Nature-Sept. 26. 2200 w.

†1850. The Elective System as Adopted in the Michigan Mining School. M. E. Wadsworth (Describes the working of this system, introduced by Pres. Wayland of Brown University, and developed by Pres. Eliot, of Harvard, in the school named; predicting its ultimate adoption in all engineering schools). Am Geol-Oct. 2000 w.

1852. Tile Making in the Netherlands. Gustav Benfey (An interesting popular description of the details of the industry illustrated. First number treats of tempering and mixing). Brick-Oct. Serial. 1st part. 1400 w.

†1863. "Apergy": Power Without Cost. Charles Morris (A statement of the results of an investigation of the Keely motor, and an account of a visit to the workshop. Mr Keely claims to have successfully handled the problem of drawing energy directly from the elements of nature). New Sci Rev-Oct. 5000 w.

†1864. The Past and Future of City Traction. F. Jarvis Patten (A review of the various systems now in use with the prophecy that in the near future the horseless vehicle will move silently along city streets—probably propelled by petroleum or gas engines). New Sci Rev-Oct. 3800 w.

1880. Agricultural Experiment Stations (Inviting attention to Bulletin No. 26, just issued, which gives a brief summary of the objects of these stations in the United States, and their work as now conducted). Gar & For-Oct. 9. 1200 w.

1882. Lighthouse, Buoy and Lightship Illumination. Ill. (Historical account of illuminants used. In the present day the majority of lighthouses depend upon kerosene oil. Interesting article dealing fully with the subject). Sci Am Sup-Oct. 12. 4500 w.

†1884. Importance of the Trade in Old Rubber Shoes (The trade in rubber scrap is now most thoroughly organized in the west and northwest. Reclaimed rubber not an adulterant. It is a cheaper product, equal to the crude for some purposes, and even better for others). Ind Rub Wld-Oct. 10. 1500 w.

†1885. Government Tests of Rubber Springs (Tabulated statements of tests as they were taken down at the Arsenal, Watertown, Mass., where the experiments took place). Ind Rub Wld-Oct. 10. 400 w.

BOOKS OF THE MONTH

A TEXT-BOOK OF STATICS. BY WILLIAM BRIGGS, M. A, LL. B., R. A. S., general editor of the University Tutorial Series, principal of University Correspondence College, and G. H. Bryan, M. A, Smith's Prizeman, fellow of St. Peter's College, Cambridge. New York: W. B. Clive, 1895 [220 pp, 7″×4¾″. Price, 40c]

AN elementary course of statics is here supplied, which excludes those facts of the science requiring a knowledge of trigonometry on the part of the student. An effort has been made to lessen the difficulties usually encountered by beginners, here foreseen by the authors, who are experienced instructors in statics and dynamics. This purpose is accomplished by hints and explanations, which, without removing the necessity of mental effort, direct the pupil's mind, unconsciously to himself, toward the intellectual point of compass where lies the truth he seeks. One of the best features of the book is the profusion of examples to be worked out. The solving of such examples will impress the principles of statics upon the memory more than any other exercise. The examples are framed with a skill that can come only by experience in teaching.

THE ELEMENTARY PRINCIPLES OF MECHANICS BY A. Jay Du Bois, C. E., Ph. D., professor of civil engineering in the Sheffield Scientific School of Yale University: author of "Elements of Graphical Statics," "The Strains in Framed Structures," etc. Volume I, Kinematics. Volume II, Statics. New York: John Wiley & Sons, 1894. [Volume I, 231 pp., 6″×9″. Price $. Volume II, 392 pp, 6″×9″, cloth. Price, $4 00.]

THE same perspicuous style and judicious method that have characterized the author's previous admirable treatises are at once perceived in these books. Professor Du Bois stands in the front rank of American text-book writers, and the subjects he treats are presented with a skill matured by experience in teaching, and a knowledge of the easiest and best approaches to difficulties. The books are well printed and bound. Numerous practical examples for the application of principles are supplied; and in adapting these to the minds of students the author has displayed his skill as an instructor no less than in his accurate enunciation and clear explanations of physical laws. The books are entirely up to date, and in full accordance with the most recent accepted physical theories; they will, therefore, undoubtedly become authoritative reference books, as well as text-books for use in the class-room.

THE MODERN MACHINIST: A PRACTICAL TREATISE on Modern Machine-Shop Methods, describing in a comprehensive manner the most approved methods, processes, and appliances applied in present practice for cutting, shaping, fitting, erecting, and finishing metal work on the vise, forge, lathe, planing, shaping, slotting, milling, drilling, grinding, and other machines. By John T. Usher. Illustrated by 257 entirely new and original engravings made expressly for this work. New York: Norman W. Henley & Co, 1895 [322 pp, 5″×7½″, cloth. Price, $2.50]

DIFFERING from others previously written and having a somewhat similar title, the treatise deals rather with improved methods and appliances for handling work on machine tools than with the construction of these tools, in which the author conceives that improvement has not been so marked as in modes of using them. From this starting-point the whole subject is discussed in a practical way by the author, who, from the character of the work before us, appears to have had an extensive experience in mechanical practice, and to have profited thereby to an extent which renders him competent to instruct others. The drawings are very largely in perspective, which is rather a unique feature in a work of this kind; they are line drawings with very little shading, and are carefully and clearly lettered, thus affording very ready reference to parts of machines mentioned in the text. The book is claimed to be thoroughly up to date.

A MANUAL OF MARINE ENGINEERING, COMPRISING the designing, construction, and working of marine machinery. By A. E. Seaton, lecturer on marine engineering to the Royal Naval College, Greenwich; member of the Institution of Civil Engineers; member of Council of the Institution of Naval Architects; member of the Institution of

Mechanical Engineers, etc. With numerous tables and illustrations reduced from working drawings. 12th edition, revised throughout and enlarged. London: Charles Griffin & Co., Ltd., Exeter street, Strand New York: D. Van Nostrand Co., 23 Murray and 27 Warren streets, 1895. [525 pp., 5½″ × 8⅛″. Price, $6 00.]

THE remarkably favorable reception this book received when its first edition was published guaranteed that it would pass through many editions. Marine engineers have always regarded it as a standard authority. In this twelfth edition the revisions have brought it completely up to date. The modern innovations in marine engineering, such as torpedoes, tubular boilers, etc., are now incorporated in the scheme of the book, as are also appliances like feed-water heaters, evaporators, separators, and other new appliances for marine engineering service. In every respect that makes a good book this treatise cannot be too highly commended.

PROSPECTING FOR GOLD AND SILVER. BY ARTHUR Lakes, late professor of Geology at the State School of Mines, Golden City, Colorado, author of "Geology of Colorado and Western Ore Deposits," "Geology of Colorado Coal Deposits," etc., Scranton, Pa: The Colliery Engineer Co. [207 pp., 5½″ × 7½″. Cloth. Price, $1.]

A COMBINATION of theory with practice in prospecting for minerals. Out of material contained in larger works have been culled such portions as are of immediate practical use to the prospector, and this information has been simplified and rearranged in a very skillful manner. The book is also based upon the personal experience of the author in the field, and of miners and prospectors comprised in his personal acquaintance. The valuable experience of members of the United States geological survey, with whom Mr. Lakes was at one time associated, has been made useful also. The limited number of minerals with which the prospector is likely to meet are very thoroughly described and pictured. The considerable variety of veins and ore occurrences are described and illustrated, the material for this purpose having been derived from occurrences in the principal mining camps in Colorado; and their geology, ore deposits, prospecting characteristics, etc., are given as the best examples and lessons of prospecting fields in the West. These examples are typical, and one who knows these camps thoroughly will be prepared for prospecting in almost any Western mining region. A valuable feature is contained in hints on the examination and reporting on mining properties, and the tricks, such as salting, etc., by which frauds are sometimes perpetrated. The book is of such size that it can be carried in the prospector's pocket, and is therefore very convenient for reference in the field.

ENGINEERING CONTRACTS AND SPECIFICATIONS, Including a Brief Synopsis of the Law of Contracts, and Illustrative Examples of the General and Technical classes of various kinds of Engineering Specifications. Designed for the use of students, engineers and contractors. By J. B. Johnson, C. E., Professor of Civil Engineering, Washington University, St. Louis, Mo. Member of the Institution of Civil Engineers; Member of the American Society of Civil Engineers; Member of the American Society of Mechanical Engineers, etc. 1st edition. Engineering News Publication Co. New York, 1895. [Cloth. 422 pp., 6″ × 9″. Price, $4.00.]

THE title gives a sufficient idea of the general character of this work. As specification writing is, in general, very imperfectly performed, and as imperfections of specifications give rise to much misunderstanding, and even to costly litigations, the information herein offered, relating to the law of contracts and specifications, together with the forms presented, will be a welcome aid to engineers and contractors in the preparation of this class of documents.

BULLETIN OF THE UNIVERSITY OF WISCONSIN, ENGINEERING Series, Volume I. No. 5. An Experimental Study of Field Methods which Insure to Stadia Measurements Greatly Increased Accuracy. By Leonard Sewal Smith, B. C. E., Instructor in Engineering. Published by Authority of Law, and with the Approval of the Regents of the University, Madison, Wisconsin. Published by the University, 1895. [145 + V pp.]

THIS is a valuable and important contribution to topographical and hydrographical methods, it being especially adapted for taking topography and hydrography, with or without the control of a triangulation, for meandering roads and rivers, and for making preliminary railroad surveys. That the method has also a much wider field of usefulness is indicated by the fact that a member of the American Society of Civil Engineers is at present sub-dividing forty thousand acres of Texas land into forty-acre tracts by the Stadia method.

NEW TRADE CATALOGUES.

Jeffrey Manufacturing Co., Columbus, O., U. S. A.=Catalogue, 16 pp., 9" × 4". [Describes and illustrates Jeffrey Patented Coal-Mining Machines, including drills, electric mine locomotive, elevating and conveying machinery, complete coal-mine equipments, coal-handling machines, etc. A handsome publication.]

American Boiler Co., 94 Center Street, New York, U. S. A.=Pamphlet, 20 pp , 6" × 9". [Describes and illustrates the "Spence" hot-water heater for heating by hot-water circulation; contains also an essay on hot-water heating, such as is necessary for the information of purchasers, with table of dimensions and capacities, and a long list of references to purchasers who have the heater in use.]

New York Central Iron Works Co , Geneva, New York, U. S. A.=Pamphlet, 26 pp., 3¼" × 6", and 8 slips [each containing a testi, monial letter, one of which is an autograph letler from an assistant quartermaster, U. S. A.-testifying to the satisfactory working of twenty, nine boilers used for house heating, officers-quarters, barracks, and other public buildings].

Charles D. Mosher, No. 1 Broadway, New York, U. S. A.=Pamphlet, 26 pp., 4" × 6¾", entitled "The Steam Separator, its Object, Action, and Application" [also containing a description of the Mosher Separator and enumeration of its uses, with illustrations and a table of dimensions, &c.]

C. W. Hunt Co., N. Y., U. S. A.=Catalogue No. 9506, "Coal Handling for Steam Generators," 52 pp , 6½" × 9". [Describes and illustrates the operation of handling coal and ashes in large plants, particularly in power stations, water works, on wharves, for railroad purposes, etc., etc. Very liberally and handsomely illustrated, and containing a large amount of information upon the subject.]

Interior Conduit and Insulation Co., New York, U. S. A.=Leaflet, 4 pp., 7" × 8¼". [Describes and illustrates the Lundell generators for gas-engine service.]

Walburn-Swenson Co., Chicago, Ill., U. S. A.=Pamphlet, 8 pp., 7" × 9½". [Illustrates and describes the "Cotton Ginners' Compress" combining the cotton gin and compress in one machine, and contains testimonials from various authoritative sources as to the value of invention.]

W. D. Forbes & Co., Hoboken, N. J., U. S. A.=Catalogue, 19 pp., 6" × 9". [Illustrating and describing high-speed electric light engines, milling machines, revolution counters, hydraulic hand-pumps, etc.]

Proceedings of the Meetings of the American Railway Association held at the Planters' Hotel, St. Louis, Mo., April 17 and 18, 1895. [103 pp., 7|½p1 ×da" eo"

New Era Iron Works Co., Dayton, O., U. S. A.=Catalogue, 27 pp., 3½"×6". [Describing the "New Era" engines for gas and gasoline.]

The Lane and Bodley Co., Cincinnati, O., U. S. A.=Catalogue, 74 pp., 6"×9". [Describes and illustrates, with price list, the line of Columbian Corliss engines, with tables of performances and essay on first-class engine performance and feed-water heating; also directions for erection and adjustment of the engines.]

Hogan Boiler Co , Middletown, N. Y., U. S. A.=(1) Pamphlet, 8 pp., 7"×10", "Proofs." [The discussion of advantages which the construction of the Hogan boiler is claimed to possess over all other boilers.] (2) Pamphlet, 1895, 9 pp., 7"×10". "Truths and Proofs," [Adds to the foregoing a statement of operations of some of these boilers in use.]

The Ansonia Brass and Copper Co., New York, U. S. A.=Pamphlet, 36 pp., 4"×6". [Describing the Tobin bronze, its physical and chemical properties, instructions for ordering, account of tensile strength, etc., and testimonials.]

National Lead Co., New York, U. S. A.=(1) Pamphlet, 16 pp., 5" × 8". "Concerning Babbitt or Anti-friction Metals." (2) Pamphlet, 29 pp., 5"× 8". "Concerning Red Lead." (3) Pamphlet, 24 pp., 5" × 8". "Red Lead, and How to Use it." [The last-named pamphlet is an essay on the permanent protection of iron and steel, which, it is claimed, can be made certain by red lead, linseed oil, and proper application.]

International Permanent Exhibition Co , New York, U. S. A.=Pamphlet, 22 pp., 5⅜" × 6¼". [Containing prospectus of the company, which proposes to establish a permanent exhibit of the labor products of all nations at the Industrial Building, at 42d and 43d streets and Lexington avenue, New York city.]

The Carson Trench Machine Co., Charlestown, Boston, Mass., U. S. A.=Catalogue B, 34 pp., 9" × 6". [Descriptive of the Carson-Trainor hoisters and conveyors for excavating and refilling all kinds of trenches.]

The Cleveland Machine Screw Co., Cleveland, O., U. S A.=Catalogue, 1895, 32 pp., 3¼" × 5⅝". [Descriptive of the New Process hardened steel balls. Describes, also, the process by which these balls are manufactured, with testimonials from those who have used them, and a list of purposes to which they can be applied.]

The Cleveland Machine Screw Co., Cleveland, O., U. S. A.=Illustrated catalogue, 31 pp., 7¾" × 5¼". [Describing automatic machinery for turning and finishing metal work of every description.]

The F. D. Cummer & Son Co., Cleveland, O., U. S. A.=Catalogue, 30 p., 9" × 6". [Describes and illustrates new and important features, both in principle and construction, distinctly new drying apparatus and methods, and different modifactions of furnace construction and system for supplying hot air to drying tunnels or rooms for the drying of brick, tile, pottery, and any other materials requiring moderate temperatures.

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MONEY AND BANKING.*

By Horace White.

I.—FIRST PRINCIPLES AND THE GOLD STANDARD.

ON the 25th of February, 1862, the government of the United States made its paper evidences of debt legal tender between individuals. The nation was thus sent upon the wrong road, and has been toiling in a wilderness ever since. In addition to the injustice which it wrought, the legal-tender act filled the public mind with misconceptions and delusions on the subject of money. So it came to pass that, although we adopted irredeemable paper with the greatest reluctance, we were willing to flounder in it 14 years after the supposed necessity for it had passed away. Then, partly by design, partly by chance, we resumed specie payments; but the people had, to a large extent, lost sight of the fundamental principles of money. The misconceptions and delusions remained, the most dangerous and widely prevalent being the notion that mere quantity is a desirable thing, and that the government can produce quantity and ought to.

It is the aim of this work to recall attention to first principles. For this purpose it has been deemed best to begin at the beginning of civilized life on this continent, and to treat the subject historically. The science of money is much in need of something to enliven it. If anything can make it attractive, it must be the story of the struggles of our ancestors with the same problems that vex us. The reader will find an abundance of these in the following pages. Indeed, a complete and correct theory of money might be constructed from events and experiences that have taken place on the American continent,

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* Mr. Horace White, the distinguished economic writer, and editor of the New York *Evening Post*, has just published, through Messrs. Ginn & Co., Boston and London, a

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even if we had no other sources of knowledge. This may be said of the science of banking also. All the wisdom and all the folly of the ages, as to these two related subjects, have been exploited on our shores within the space of less than 300 years.

Very few persons, if any, are satisfied with our present monetary condition. While I write these lines, a withdrawal of $2,350,000 gold from the treasury causes a fresh tremor and confusion of tongues. Everybody assures everybody else, and tries to assure himself, that it is of no consequence. Probably no harm will come of it; but why should it be noticed at all, except by a few dealers in foreign exchange? Because the public treasury undertakes to maintain the ultimate gold reserve of the country, and because people doubt whether it can do so at all times. Are these doubts unreasonable?

Suppose that the government were out of the banking business altogether, its fiat money retired, and the treasury restricted to its normal and proper business of collecting and distributing public revenue. In that case the duty of redeeming the paper circulation and maintaining a sufficient gold reserve for the purpose would devolve on the banks, and would be discharged automatically. The banks would learn by experience how large a reserve is required generally. In emergencies, when, for any reason, more should be required, they would obtain the means from their maturing bills receivable. This would come to them either in the shape of their own circulating notes, thus lessening the call upon them for gold, or in gold itself, which the mercantile community would be obliged to procure and send in to them. Of course this implies a curtailment of discounts, but curtailment is not avoided under the present system. The curtailment in the panic of 1893 was as severe as it could ever be if the banks were solely

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small volume entitled "Money and Banking," which is destined to play a very important part in the solution of the currency problem in the United States. The whole monetary history of the American continent is graphically set forth in chronological order; the facts of our experience are paralleled by the experience in other civilized countries; every page of the text is characterized by bold side-heads in black type, rendering it invaluable for reference; there is a complete absence of the technical terms and mystifying logic which usually burden discussions of finance; and, in addition to an appendix of valuable facts and a list of the vast number of important books and pamphlets consulted in the preparation of the work, an excellent index is given in the rear of the volume. Not alone the most important contribution to the literature of the subject up to date, it may be fairly described as a classic in the literature of finance, destined to exert a healthful influence for generations to come.

Rather than attempt any original review of the work, it has been thought best to permit Mr. White to speak for himself. We therefore present a series of quotations designed to present an outline of the author's argument. The first instalment is devoted to "First Principles and the Gold Standard," and the second will be devoted to "Representative Currency and Banking." From them our readers can form a fair general idea of Mr. White's argument; but it is scarcely necessary to say that this will not be sufficient for the man of intelligence who desires to be *thoroughly* well-informed. Indeed, this is a book which should find a place in the library of every intelligent reader of these pages, for we can never hope for uninterrupted progress in constructive enterprise until the money question is finally and rightly settled.—THE EDITOR.

responsible for the redemption of the paper circulation. But probably there would have been no panic at all at that time, if the government had been restricted to its proper business, and had not been issuing fiat money in large quantities.

It is thus apparent that the first step toward a rational system is the retirement and cancellation of the legal tender notes and the restriction of the treasury to the duties for which it was originally and solely designed. When this is done, the public mind will be so cleared that other reforms, and especially banking reform, may be hopefully undertaken.

My opinion is that the Scotch bank system is the best in the world, and that we might borrow from it, as the Canadians have done, to our advantage. There are only ten banks in Scotland, but they have nearly one thousand branches, reaching every hamlet in the nation. Deposits are received and loans are made at each branch, but the branches pay out only the notes of the bank, which are redeemable at the head office. So it is necessary to have real money only in one place, instead of perhaps one hundred different places. At the branches the bank's circulating notes answer the purposes of retail trade, while checks drawn against deposits answer all other purposes. Thus the maximum of business is done with the minimum of capital, which is the *raison d'être* of banking. In other words, credit has been systematized in Scotland to the last degree, and is found to answer all purposes so long as the paper sovereign can be converted into the gold sovereign at some convenient commercial center, at the pleasure of the holder.

Money is anything that serves as a common medium of exchange and measure of value. It need not be a good measure; it is only necessary that it should be the agreed measure of any time, place, or people. We are now speaking of real money,—not of its representatives or substitutes.

Among the things used as money by various people within the historical period are cattle, cacao beans, salt, silk, furs, tobacco, dried fish, wheat, rice, olive oil, cocoanut oil, cotton cloth, cowry shells, iron, copper, platinum, nickel, silver, and gold. It would be difficult to say what had not been used as money at some time or place. Our own history furnishes an abundance of curious examples, the most instructive being the tobacco currency of the colonial period. It may be said that Virginia grew her own money for nearly two centuries, and Maryland for a century and a half. Hardly any form of currency could have been worse, the fluctuations in its value being extreme and incessant, and the social disorders produced by it enormous.

It is evident that money, when real, is a commodity, and, when representative, represents a commodity. This is true of gold as well as of beaver skins, of tobacco, of rice, or of wampum. No invention or discovery since the world began has been of so great service to mankind as that of a common measure of value. One can hardly imagine a world existing without it. To say that the most indispensable thing in the world is a thing of no value is a contradiction of terms absolutely blighting to the human intellect. As a matter of fact, however, all the things that have been used as money have possessed other value, and we have the best reason to believe that this other value led to their use as money in every instance, without a single exception.

All trade is barter, or the exchange of property and service for other property and service. The selling of wheat for gold, and then selling the gold for cloth, are really two acts of barter. The word barter is commonly used to signify the exchange of property without the use of money. It must be borne in mind, however, that *all* trade is barter, even when the precious metals are employed as intermediaries,—the latter being articles of barter also, and possessing the same value as the things for which they are exchanged. *The whole science of money hinges on this fact.*

It must not be assumed that gold is absolutely stable in value. We are concerned at present only with the comparative steadiness of value of different things,—as, for example, gold and tobacco. If gold is subject to fewer changes of purchasing power than tobacco, it is better fitted to serve the purposes of money, and will sooner or later supplant it in that function. If it is subject to fewer changes than any other known substance, it will supersede all others. The fact that it is not wholly free from variation itself will not prevent it from becoming the sole and universal money of civilized mankind.

When, in 1834-37, the United States changed its ratio to one to sixteen, gold was overvalued, just as it had been in England in 1717, and with the same consequences. Our silver began to be exported. The minor coins, being of proportional weight with the dollar, were melted and exported, and their place in the circulation was taken by light-weight foreign coins, principally Spanish and Mexican. Two halves, four quarters or ten dimes, if new and of full-weight, were worth about 2 1-4 cents more than a gold dollar. Consequently they would be collected by brokers, melted, and exported. But two halves, four quarters, or ten dimes that had lost 2 1-4 cents' worth of silver by abrasion would circulate, because there would be no motive to melt or export them. There would be no profit in it.

When the great outpouring of gold from California and Australia began in 1848 and subsequent years, the price of silver rose so that the dollar of that metal was worth in the market $1.04 in gold. This fresh advance of 1 3-4 per cent. in the price of silver carried still more of those coins out of the country,—*i. e.*, all that were worth by weight more than 100 cents per dollar in gold. So the remaining ones became lighter and smoother. Finally it became apparent that, if full-weight silver coins would not circulate on the ratio of one to sixteen, while those of light weight would circulate, it would be safe to *make* minor coins (halves, quarters, etc.) designedly of light weight on government account, of limited legal tender. There would be no profit in exporting such coins, because they would not sell as bullion for as much as it would cost to collect them.

Acting upon this principle, congress, in 1853, passed a law providing for the coinage of new half-dollars, quarters, dimes, and half-dimes about seven per cent. lighter than the old ones. These were to be coined from silver bought by the government, and not otherwise, and were to be sold to the public at par,—*i. e.*, 100 cents gold for each 100 cents of the new coins, although these were worth considerably less, at par. The new coins were legal tender for only $5.00 in one payment. There was no longer any motive to export the halves, quarters, etc., since they could not be collected for less than 100 cents per dollar and could not be sold for more. Thus we, in our turn, found out that the system suggested by Adam Smith in 1776 would work. Not only would it work, but it has proved to be the only system that would keep both metals in circulation under all circumstances. It has proved also to be the system that would call into circulation the largest possible amount of both gold and silver at any one time and place.

Such is the underlying principle of a subsidiary coinage, of whatever metal or substance it may be composed. Our silver dollar, the French 5-franc piece, and the German thaler circulate at par on the same principle. They are subsidiary coins of larger size. They are *now* worth as metal only one-half of their nominal value, but, since they are limited in number, and since the governments receive them for all public dues, they are not depreciated. Receiving them for public dues is one way of redeeming them. Our coins, smaller than $1.00, whether of silver, copper, or nickel, are redeemable by the government in gold when presented in sums of $20 or more.

If subsidiary coins circulate at a value which is largely imaginary, the question may be asked: Why not make them of some other metal, or even of paper? There are no reasons except custom and convenience. A coin not heavier than a half-dollar is more convenient than a piece of paper; it is cleaner, and in the long run is probably cheaper, as it does not require frequent renewal. A cheaper coin might be made out of some other metal, but it is always best to conform to the habits of the people. Having been born and nurtured in a silver subsidiary coinage, no good reason is apparent why we should depart from it.

The United States adopted the double standard of gold and silver in 1792. Mr. Raguet wrote to the *National Gazette* in 1820 to explain the reason for "the disappearance of gold from the United States." Two years later he wrote again on the same subject, saying "that, although the coinage of gold continued to be large ($41,319,030 in 1820), not a gold coin was anywhere to be seen in circulation." The facilities of the mint were simply used by merchants to certify the weight and fineness of gold for exportation. There were stirrings in congress on the subject of a change of ratio as early as 1818. Various projects were brought forward. Scarcely a session passed without some movement in one house or the other. In 1834 the Gold Bill, as it was termed, was reported by a special committee of the house, of which Mr. Campbell P. White, of New York, was chairman. The debates and the newspaper discussions show that there were three considerable forces at work to promote the passage of the Gold Bill. One was the desire to have gold again in circulation. This desire found apt expression in the words of Thomas H. Benton, who declared that the object of his endeavors was:

> To enable the friends of gold to go to work at the right place to effect the recovery of that precious metal which their fathers once possessed, which the subjects of the European kings now possess, which the citizens of the young republics to the south all possess, which even the free negroes of San Domingo possess, but which the yeomanry of this America have been deprived of for more than 20 years, and will be deprived of forever unless they discover the cause of the evil and apply the remedy to its root.

The production of gold in the southern States had arisen from $5000 in 1824 to $868,000 in 1833, and the belief was generally entertained that, if the mint valuation of gold were raised, it would give the producers of that metal a pecuniary advantage. In other words, it would serve as a measure of "protection" to that industry. This was an entire mistake, but it had a considerable influence in promoting the passage of the Gold Bill.

The third impelling force was the bank controversy then raging. This was largely a party question, the supporters of President Jackson being generally supporters of the Gold Bill. The silver standard, it was contended, promoted the circulation of bank-notes because silver was bulky and heavy. The gold standard, on the other hand, would curtail bank-note circulation, because gold was easily handled. Hence the opponents of banks, were in favor of the Gold Bill.

The bill, as reported to the house by Mr. White, provided for a ratio of 1:16.60, but, when it came up for discussion, Mr. White moved an amendment making the ratio 1:16, and this amendment was adopted without a division.

It was perceived on both sides that the passage of the bill would make the United States a gold-standard country in practice. Why, then, was the double standard retained in theory? One reason was that a great many contracts were in existence, such as ground leases and bonds and mortgages, expressly calling for payment in silver. Another was that the smaller coins (halves, quarters, and dimes) were of proportional weight with the dollar. These, it was thought, could not be dispensed with, the principles of a subsidiary coinage being then imperfectly understood. So the double standard was retained in law, although discarded in practice.

In 1866, Mr. John J. Knox, who then had charge of the mint and coinage matters in the treasury department, recommended a revision of all the laws relating to the mint. Secretary Boutwell approved of the suggestion. Mr. Knox and Dr. Linderman were appointed in 1869 a committee to make such revision. They presented their report with a draft of a bill in 1870. The bill passed the senate on the 10th of January, 1871. It made the gold dollar a unit of value, and it dropped the silver dollar from the list of coins. The bill failed in the house for want of time. The forty-first congress having expired without final action, it came up again in the forty-second. It passed the house May 27, 1872, by yeas 110, nays 13. It passed the senate January 17, 1873, without a dissenting vote. The metal in the silver dollar at that time was worth 2 cents more than the gold dollar. No objection to the bill was heard until the price of silver had fallen so that the silver dollar, if there had been any, would have been worth less than the gold dollar. Then it became fashionable to say that the bill was passed surreptitiously. The truth is that the bill was before congress 2 years and 10 months, that it was printed thirteen times by order of congress, that the debates on it occupy sixty-six columns in the senate proceedings and seventy-eight columns in the house proceedings, and that the discontinuance of the silver dollar was specially discussed in the house.

Let us imagine for a moment that silver had not fallen in price after 1873. Would anybody have missed the silver dollar? Would anybody have doubted that the gold standard was brought about in this country by natural causes operating upon men's minds in the same way as it was in England?

It is said that the single gold standard has produced a disastrous fall in the prices of commodities. If it could be shown that the single gold standard had caused the decline in prices which has taken place since 1873, I should consider that fact its best title to be considered a benefit ; because it is demonstrable that wages have advanced during the same period, with the result of giving to the great mass of the people more comforts for their labor than they could command before. This is clearly shown by the report on wholesale prices, wages, and transportation made by the senate committee on finance, March 3, 1893,—a work which has never been surpassed in this or any other country in fullness, thoroughness, and impartiality.

After examining this report, Professor Taussig says :

> All in all, the figures show that the purchasing power of money wages has been rising steadily for at least 20 years, and that the decline in prices since 1873, and especially since 1882, has been a source of prosperity, and not of depression, to the community at large.

It cannot be shown, however, that such decline in prices as has taken place in recent years has been due to an appreciation of gold. Mr. David A. Wells, in his work entitled "Recent Economic Changes," accounts satisfactorily for the decline in prices of all the staple articles of commerce which have really declined since 1873, by new inventions and facilities foı producing or transporting the same. Mr. Wells takes up each article separately. He shows that some articles have risen in price during the period named and some have remained nearly stationary, while among those that have declined the widest variations exist as to the percentage of decline, all the changes being traceable to known conditions of supply and demand.

We hear much about the "scramble for gold." What is meant by this phrase? Generally a thing is not scrambled for, unless it is desirable. The simple truth is that gold is the only money of civilized nations. We are all aiming as individuals to get as much money as we can. As nations are composed of individuals, it is no mystery that nations appear to be doing the same. Calling it a scramble serves only to create prejudice among the unthinking, because a scramble usually takes place in the dirt and is attended by the display of evil passions.

It is said, finally, that there is not gold enough in the world to do the business of the world. This statement would be of no consequence, even if it were true, since the real question is whether there is enough for the gold-using portion of the world, which question may be answered in the affirmative, as this portion of the world is giving ocular proof of the fact every day. As regards the future, there is every prospect that the increased supply will keep pace with any increase of demand, the production during recent years having advanced by leaps and bounds.

SIDE LIGHTS ON THE SOUTH AFRICAN GOLD BOOM.

By Albert Williams, Jr.

NOTHING has ever happened in the financial world comparable with the existing excitement about "Kaffir" stocks in the London and Paris exchanges, and in less degree throughout the other European money centers. Fortunately thus far the mania has not reached the United States, and is hardly likely to before the impending catastrophe occurs. People not on the scene, and depending for information solely upon newspaper accounts, but dimly realize the magnitude of this latest speculative upheaval. Yet beside it the South Sea bubble, the Mississippi scheme, the tulip craze, the gold speculation during the civil war, the Great Bonanza and the Leadville deals, and the Panama canal fever, pale into utter insignificance. If we consider either the volume of paper floated, the amount of actual hard cash involved, or the number of investors and speculators interested, financial history records nothing like it. Here is something in real life which, if told in a novel, would seem too utterly exaggerated and fantastic for even the novelist's license. Had Zola written "Money," or Dumas "Monte Cristo," or Chamberlain "Six Thousand Tons of gold," or Haggard "King Solomon's Mines," after instead of before the events of the past few months and what is now transpiring and still to come, they would have been warranted in materially expanding their imaginations. Think of the impulse which can lead otherwise sane persons to put more than a billion, possibly a billion and a half, of money or margins into paper of the intrinsic value of which most of them know little or nothing!

There are all shades of mining excitements, ranging from the oft-repeated "rushes" to localities of actual or supposed great discoveries, to "booms" which are purely artificial and fictitious; and between the two extremes indefinite gradations, in which mining and speculation are mixed in varying proportions. This latest instance is a marked example of the composite type, having a foundation in solid mineral wealth on which has been built, haphazard and indeed without serious premeditation, an overwhelmingly disproportionate superstructure of the wildest speculation. The old saying holds good that there are just two ways of making money out of mines: one by taking it out of the ground, in the form of dividends earned by legitimate mining; the other by making it on the street, or, in plain English, by taking it out of other people's pockets, and considering the stock certificates merely as convenient vehicles for gambling. By each of these methods colossal fortunes have been obtained. Of the two the latter is no doubt the easier and the more expeditious ; but it has this disadvantage, from the ethical point of view, that there is no accretion to the general wealth, but only a transfer of money from one to another, with a final concentration in a few hands, which cannot but be deplorable as a matter of financial economy. It must be remembered that to produce a single multi-millionaire in this manner implies the combined losses of a myriad of small and unlucky speculators.

That the South African gold mines presented an inviting field for legitimate investment and development is unquestioned. Many of them are very valuable properties, and have yielded handsome profits to their owners ; while the known gold-bearing area is very large and may be depended upon for a long-continued output, which for an uncertain length of time will undoubtedly show a steady increase with the extending of the workings and augmented milling capacity. So much money as is now being put into actual development of the mines and construction of new reduction plants cannot but result in larger returns. Up to a certain point, therefore, the recent and present speculative excitement has been beneficial to the real work of mining ; it has acted as a stimulus to bring in capital which might not have been secured on the merits of the mines as reasonable investments. But the whole thing has been overdone. There have been no startling discoveries of late. There has been no rush of prospectors, although an immense number of claims have been sold ; there have been no new finds of importance. The mines are there, just as they were a year ago : some of them turning out their regular quotas of gold ; others engaged in dead work to reach pay ground previously tested with the diamond drill, or presumed, on geological evidence, to exist ; and others still being prospected on chance, as always happens in new mining districts. The mines have not changed, save in the direction of a natural and healthy growth ; the difference has been in London and Paris. Once these same mines were underrated ; then their steadily-increasing yield began to attract attention, and they became justly appreciated ; next the public, which would not touch them only a little while before, was seized with a mad infatuation and stampeded for shares, and the market ran away with itself, surprising the earlier promoters, who engineered the first deals, and leaving many of them behind. And lastly —— ?

In a preface to a book just issued, entitled "The Gold Mines of the Rand," by Messrs. Hatch and Chalmers, Mr John Hays Hammond, a California mining engineer who has recently examined the

Transvaal mines, makes this strong statement: "It is obviously impossible to make an approximate estimate, but I would regard as well within the bounds of conservatism the prediction that the annual output before the end of the present century will exceeed $100,000,000 worth of gold." If Mr. Hammond's estimate proves to be correct,—and it is less sanguine than some which have been put forth,—this would mean an increase of nearly 80 per cent. over the world's annual gold output of a few years since.

The gold production of the Rand since the first regular mining in 1887 has been as follows, expressed in troy ounces at the bullion value of about $18.50 per ounce:

1887	23,155	1891	729,247
1888	208,121	1892	1,210,867
1889	369,557	1893	1,478,473
1890	494,817	1894	2,024,159

For the first 9 months of 1895 the output was 1,711,837 ounces. The annual yield is, therefore, now at the rate of about $41,000,000. The figures for all of the South African gold fields vary somewhat, but the outlying districts produce something over $5,000,000 annually, in addition to the Rand production. For 1894, the last full year, one statement places the total yield at $37,988,076 (selling value), of which $30,412,782 came from the Rand. A writer in the New York *Mail and Express* states the number of stamps in operation in 1894 at 2300, and this year there are 2600, upon which crushing capacity is based an estimate of over $50,000,000 for 1896, at which rate the South African gold mines will lead those of the United States in 1896 or 1897.

So far, it will be observed, the production, while large, is by no means without precedent. It is in the assumed reserves of ore, and the vague estimates of future returns, that the peculiar attraction of the South African mines is to be found. California, which altogether has produced nearly $2,000,000,000 worth of gold, in the palmy years of the early fifties yielded $55,000,000 to $60,000,000 annually, and Australia has nearly as good a record. But in California and Australia there was for a long time practically no speculation; in both cases the excitement ran in the direction of the actual getting of gold, not of floating shares, and both countries swarmed with eager gold-seekers equipped with pick, shovel, pan, and rocker, ready to face any hardship and privation to win the coveted metal, but wholly innocent of the advanced arts of the modern promoter. In California the yield for some time averaged about $6000 a year for each man, woman, and child, including Indians, in the State,—much more, of course, for each working miner,—and in the irregular distribution the more lucky ones far exceeded the average. But the California mines were shortly brought into the humdrum stage of quiet, systematic mining, with little speculation (though San Francisco has witnessed exciting times over the stocks of Nevada and Idaho mines) ; and latterly, owing to the suppression of most of the hydraulic mining, the annual yield is only about a fifth of what it was at its best.

The Nevada mines (popularly classed as silver mines, although most of them gave large percentages of gold) affected the stock markets much in the same way as the South African mines have done, though always on a smaller scale. That is, there was first the rush of prospectors; the opening of mines ; in some cases very heavy outputs ; then the floating of a vast amount of stock,—some of it valuable, some utterly " wildcat " in character. The Comstock lode was used as an excuse for stock gambling, but it also had substantial merit. In all, it has produced about $360,000,000, of which about one-third was gold. In the many booms some surprising advances in stock quotations were made. When the shares were divided according to the linear feet in the claims (one share for each foot), several of the stocks rose from next to nothing to $6000 and $8000 per share. Later, when the stocks were largely watered, Crown Point and Belcher soared in a few weeks from obscurity to nearly $2000 a share. In the " big bonanza " excitement, Consolidated Virginia and California (then two separate mines), with a capitalization of $12,000,000 each, in 112,000 shares of a nominal par of $100, rose in a few months from $75 to $780 and $810 respectively, although a few years previously these same stocks had been hardly able to carry their assessments. But these Comstock deals, the cause of excitement never known in any mining speculation before, are simply eclipsed by the South African boom. At the most, the total value of all the Comstock paper at the quotations for any one day probably did not exceed $300,000,000, or at most $400,000,000. The lode is only about 4 miles long. There were about twenty or thirty claims which could be termed *mines*, and several hundred others of the species wildcat. The bulk of the production came from only four mines; all the others, no matter how prosperous for a time, in the end showed losses, the assessments far exceeding dividends, while some of the mines which never paid a single dividend were operated at a cost of several millions each. White Pine, Eureka, Reese River, Tuscarora, and other Nevada camps, and the Owyhee district of Idaho, also came in for speculative attention in their turn.

Leadville, Colorado, the next greatest American mining district after the Comstock, has produced something over $200,000,000 in silver, gold, and lead. The shares of its mines have had their ups and downs in the New York and London markets, though the general public never went crazy over them. It is worthy of note, as a warning for the immediate future, that, after the collapse of Little Pittsburg and Chrysolite, English capital for several years was very shy of American mines, or mining of any kind. The same effect followed the previous break in Little Emma and other Utah mines owned in England.

At present the gold district which is receiving the most attention of any in the United States is Cripple Creek, Colorado, where there are several very prosperous mines and an unlimited number of prospects. This district, yielding at the rate of about an eighth of the Transvaal mines, has attracted considerable foreign capital, but this has been the money of capitalists, not of small speculators, and most of the mines are owned at home.

Simultaneously with the South African deal, a lesser boom has been exploited on the London market. This is the West Australian boom, founded upon discoveries of very high-grade gold-ore in that colony. It is not at all a small boom, appraised on ordinary terms, but is left in the shade by its giant rival. The West Australian mines are at great disadvantage as to water, timber, supplies, and transportation. In spots the country is evidently very rich, but, in accordance with the invariable custom, a huge number of prospects and probably worthless concerns have been carried along by the returns from the relatively few good mines. The rush to West Australia seems to have subsided, but the mines are being worked—mostly in London!

A mining engineer, now in New York, told me a remarkable story the other day about the floating of one of the South African stocks. The prospectus, he said, was the most cynically honest one that he had ever seen. In brief, and stripped of all technicalities and verbiage, it amounted to something like this, paraphrased: "We have a piece of ground in the Transvaal, on which we are about to issue shares at public subscription. No gold has yet been found on it, but it is in the neighborhood of some very profitable gold mines, and we offer the stock on the chance that we *may* find some gold in our ground too." On the strength of this, my informant's story goes on to say, there was an over-subscription of stock, and it went at much above the nominal par the first day it was on the London exchange, at which price the total valuation for this undeveloped and untried tract of South African land represented a very large sum.

Similar stories are numerous. Very many of the stocks have been floated at much more than the nominal capitalization, the public subscribing several times over for the shares before the allotment. When the opening quotations for a new stock are much beyond the figure to insiders and their friends, it is natural to expect that in the allotment the public does not get the shares at the original subscription price, but that the shares are all taken in by the promoters at that figure and turned out on the market at the advanced quotation. This has been done over and over again in London. It is one of the perquisites of the promoters, but never before was it such a "sure thing."

Besides the stocks of mining companies, the South African boom has created a host of enterprises, such as investment companies, exploration and development companies, banks and trust companies, parent promoting companies, and subsidiary offshoots, all of them offering shares for sale, and some of them representing no actual property whatever, but merely a chance of getting hold of something to "handle." One of the most extraordinary events has been the marketing of shares in the new Barnato bank. Its nominal capital is $12,500,000. The $5 shares opened at $23, and the total valuation of its stock exceeded $40,000,000 before it had begun business. As a matter of curiosity I give here the nominal capitalization and the market price in the middle of October of twelve representative South African concerns. It should not be forgotten that at the time the promoters decided upon the amount of nominal capitalization they were nowise diffident, the main check being the fees for incorporation. The table was compiled by the London correspondent of the New York *Sun*.

	Nominal capital.	Market value.
Barnato Bank	$12,500,000	$45,310,000
Barnato Consols	6,250,000	35,155,000
British South Africa	12,500,000	107,810,000
Consolidated Gold Fields	3,125,000	59,375,000
De Beers Diamond	19,750,000	127,385,000
East Rand	3,250,000	40,625,000
Johannesburg Con. Inv.	4,000,000	25,000,000
New Jagersfontein	5,000,000	11,750,000
Modderfontein	875,000	13,350,000
Rand Mines	1,663,500	79,857,500
Randfontein	10,000,000	41,000,000
Robinson Bank	15,000,000	37,500,000
Totals	$93,915,500	$624,367,500

Comment is hardly necessary. The figures speak for themselves. These twelve stocks are extreme examples. They are not wildcats; they are the gilt-edged stocks; but how much they have been overrated is a conundrum.

The most striking figure in the financial world is "Barney" Barnato, a few years ago a penniless adventurer, and only a few months past entirely unknown to fame. Now he is worth—— well, some reports say that he would be the richest man alive if he could only "cash in" his paper holdings. To attempt to do so would be to break the market at once, which he is too shrewd to do. But he has plenty of substantial investments to fall back upon, if he does not come to grief in the London exchange. All this money, real money and paper alike, came, not from the mines, but from fortunate speculation, in which he backed his luck with a courage or a fatalism never perhaps equalled.

It cannot be said that the financial and daily press, as a whole, has done much to further the boom. On the contrary, the journals of best standing have all along sounded the note of warning. The London *Economist* many weeks ago, by way of exhibiting the extremely speculative character of the movement, took the most favorable estimate of the future output, and, by comparing it with the total market quotations on the present capitalization, easily proved that these quotations were absurdly high. Commenting on this, the New York *Evening Post* pointed out that this, at best, is unsatisfactory as a test of individual properties ; such averages merely prove that some companies or " banks " are based on unreal expectations, but leave the problem of individual values untouched. " The same process applied to all the English railway common shares, or to American shares either, would show equally poor prospects, because those stocks paying little or nothing (amounting in the United States to nearly two-thirds of the total) would pull down the average of the whole ; but should we sell London and Northwestern or New York Central on such a table ? " Conceding this objection to the principle of general averages, what the *Economist* did show was that, when quotations were only about $750,000,000 for all the Kaffir stocks, the dividends stood for an insignificant percentage, far below current rates of interest. Hence, if some of the mines were good investments, the ruck must be very bad indeed. Besides this, there is the original investment to be made good, in view of the ultimate exhaustion of the mines, either by a sinking fund or an equivalent increase in dividends. The *Statist* has plainly warned the English bankers of the danger of complications arising from their foreign correspondents, especially the French banks ; and it was the caution of the London banks in calling in foreign loans that caused the flurry in October.

What will be the outcome ? It is unsafe to predict with any definiteness as to details. Everyone, even the most unscrupulous promoters and the most sanguine dupes, knows that sooner or later there must be an end, that sooner or later must come the inevitable day of reckoning, just as always has happened. But precisely at what point the climax will be reached, and whether it will culminate in one sudden and universal smash, or whether there will be any premonitory indications, gradual breaks and recoveries, but on the whole a downward tendency, until the stage is reached at which the great body of margins are uncovered, and then a final slaughter of all South African stocks, good and bad alike,—as to this no one can tell. Many onlookers thought the top had been touched long ago, and many who went in "on the ground floor," or at what now seem to have been comparatively moderate figures, drew out months back, believing that they had carried their holdings as far as was prudent.

Once in October last it looked as though the market were going to pieces. An incipient panic set in, there was a sudden rush to realize, prices fell off disastrously; but Barnato and some of the other insiders stepped into the breach, and, by heavy purchases, stopped the decline and restored confidence. Barnato is reported to have offered to advance $100,000,000, if necessary, through his bank, on South African stocks. But the time is coming when not all the capital and credit of any one man or clique will avail to avert disaster. The magnitude of the deal is too great for that.

Three things may be set down as certain:

1. When the catastrophe falls, it will be one of the worst, if not the very worst, disasters that have ever shaken the European financial world. It may come at any moment, perhaps even before these lines are printed, or it may be indefinitely put off. No one knows. But, when it does come, it will mean ruin to thousands of small investors and the annihilation of some large paper fortunes.

2. After it is all over, there will be the usual reaction toward ultra-conservatism. Speculation, especially in mines and distant ventures of all kinds, will be at a low ebb for years in Europe,—that is, until the events of the present are partially obscured by time, and a new crop of speculators springs up.

3. The ultimate effect will be injurious to legitimate mining. Not South Africa alone, but all mining regions, will suffer. Mining requires capital, often in heavy amounts, before successful results are attainable. The money is needed for development, for mining machinery, and for reduction plants; and sometimes the whole question of profit hinges upon the ability to work on a very large scale,—that is, with a large preliminary investment. Capital is scarce or does not exist in the mining districts. It has to be sought in the great money centers. When a feeling of distrust pervades the money markets, mining investments are peculiarly sensitive and at the greatest disadvantage. Consequently it may be expected that it will be extremely hard to interest capitalists, and still more so the public, in any mining enterprise, no matter how meritorious, until the South African experience has been forgotten. Such has always been the case hitherto, and will be in this instance. In the course of time there will be a natural readjustment of ideas, but meanwhile the outlook for mining investments will be very unsatisfactory.

THE DISTRIBUTION OF ELECTRIC POWER AT NIAGARA.

By the late Franklin Leonard Pope.

ON the morning of August 26 of the present year the Niagara Falls Power Company commenced the transmission, for commercial purposes, of the electric power generated by the great hydraulic and electric plant which has been under construction for the past 5 years, and which, not alone by reason of its magnitude, but also on account of the boldness, originality, and succcess with which the many novel problems in civil, mechanical, and electrical engineering to which it has given rise have been attacked and solved, has attracted the attention and excited the admiration of the civilized world. From a technical point of view there seems to be no question that the expectations of those interested in the promotion and accomplishment of this gigantic undertaking have been fully realized. The results which have already been attained, culminating in the successful transmission of electric energy to the amount of some thousands of horse power to the works of the Pittsburg Reduction Company for use in the manufacture of aluminium, render it certain that the vicinity of Niagara Falls will in time become one of the greatest manufacturing districts of the United States, if not absolutely the greatest.

But one portion of the problem proposed to themselves by the projectors of the Niagara enterprise still awaits its solution,—the question of the transmission of power to a distance in competition with steam power of local production. Much has been said and written in reference to this question, and it is but just to say that at the present moment there exist the widest differences of opinion on the subject among presumably competent authorities. Some eminent experts do not hesitate to express their belief that power can be delivered at any point within a radius of 200 miles cheaper than it can be locally produced by steam engines of the most economical type using coal at $3 per ton, while others of equal eminence, and perhaps greater practical experience, maintain that it cannot be delivered at a profit, even at such a comparatively short distance as that which separates Buffalo from Niagara,—less than 20 miles as the crow flies. In view of the interest and attention which has been excited in every part of the world by the progress and partial completion of the works at Niagara, this has seemed to the writer an opportune time to present to the readers of the ENGINEERING MAGAZINE a summary of some of the most important contributions recently made to the discussion of the commercial aspects of the problem of electrical transmission of power, with especial reference to the case of the Niagara plant.

Professor George Forbes of London, the electrical engineer of the Cataract Construction Company, in a recent, and in some respects very remarkable, article in *Blackwood's Magazine*, has given a history of the work from his own point of view, from which many facts of interest and importance may be learned. It appears that, when the Niagara Falls Power Company was formed in the autumn of 1889, nothing had been decided upon as to the plan of the work, beyond the general conception of the vertical shafts and horizontal tail-race excavated at the lower level for carrying away the water from the turbines. The entire question of distribution for both short and long distances remained in abeyance. In 1892 it was determined that the distribution should be effected by alternating currents of electricity, and from that time forward the work was carried on in accordance with that decision. The capacity of the present tunnel is equivalent to 100,000 h. p. The turbines and electric generators are in units of 5000 h. p. each, of which three, or 15,000 h. p., are now in place. According to Professor Forbes, about $5,000,000 has been expended on the work so far as completed, so that perhaps we shall not be far out of the way if we assume that, by the time the 100,000 h. p. has been installed, the cost of construction will have been about $70 per h. p.

Professor Forbes says: "The directors have no present desire to send the current to great distances. It will pay better to create a smokeless manufacturing town in the neighborhood. If required, the power could be sent much more than 100 miles, and still be more economical than steam, even though coal is cheap there." And again: "One of the ablest of American engineers said in public 3 years ago that it was impossible to transmit the power of the Falls to Buffalo, some twenty miles, so as to make it pay; whereas we have now established the fact that the limit of distance is to be counted by hundreds of miles." Messrs. Edwin J. Houston and A. E. Kennelly, two well-known electrical engineers, published last year an interesting paper, entitled "An Estimate of the Distance to which Niagara Water-power can be Economically Transmitted by Electricity." After an elaborate computation based upon certain assumed data, the authors sum up as follows: "The broad conclusion to which an inquiry of this nature inevitably leads is that, while under ordinary conditions the commercial limit of electrical transmission of power from water powers of less than 500 kilowatts can hardly exceed 50 miles, the radius at which it will be profitable, with good fortune and management, to electrically transmit a water power aggregating 50,000 kilowatts or more is perhaps to-day 200 miles, and that it might be commercially advantageous for such a large water power to undersell large steam powers at twice this distance with no profit, in order to reduce the general expense upon delivery nearer home.'' Mr. S. Dana Greene, the assistant manager of the General Electric Company, who has had much practical experience in the installation of electric power-transmission plants, has recently expressed his belief in the substantial correctness of the views of the authorities last quoted.

It appears, nevertheless, somewhat significant that, so far as can be learned, no work has actually been commenced upon the transmission line to Buffalo. In explanation of this circumstance, Professor Forbes, in speaking of the work carried on by him as consulting electrical engineer of the construction company, said: ''I decided on all this transmission plant, and it is not now put in only because the Buffalo people want to get the power for next to nothing. There is too much 'politics' in this business at Buffalo.'' On the other hand, there are very eminent engineering authorities who do not hesitate, even now, and in the face of all that has been accomplished, to express the opinion that the real reason is that, if the electric power is furnished to the manufacturers and electric plants of Buffalo at a price sufficiently low to justify them in abandoning the steam plants now in use, the amount of profit remaining for the Niagara Power Company will be too small to justify them in undertaking to supply it from their plant at the Falls. A very instructive discussion of the comparative cost of power from different sources took place at the meeting, last June, of the American Institute of Electrical Engineers, upon which occasion Mr. Charles E. Emery, a very distinguished steam engineer, pointed out that the true basis of comparison is the relative cost of power delivered in desired quantities to the several consumers as compared with the cost of steam power on the premises. He agreed with Mr. B. J. Arnold, who had previously stated that in the best modern steam plants of say 100 h. p. the cost of power, delivered upon the engine shaft, is about 1 cent per h. p. hour,—a figure which includes interest, depreciation, attendance, and all other expenses, as well as fuel. He further agreed with Mr. Arnold's computation that, in order to compete with steam for power, electricity must be transmitted from the dynamo at Niagara to the manufacturing establishment in Buffalo, and delivered at the switchboard to the small motors used to drive the machinery of the factory, at a net price of 1.5 cents per kilowatt hour, equivalent to 1.125 cents per h.p.hour. Now, it appears that, in the contracts which the Niagara Power Company make with the consumers, the latter are required to pay for a certain maximum quantity of power, which they are not permitted to exceed, even temporarily. The schedule of prices, as ascertained from the officials of the Power Company, at the request of Dr. Emery, has been fixed at $10 per h. p. per year for undeveloped power, $13 for power delivered at the top of the turbine shaft, and $18 for electric power delivered at the terminals of the dynamo,—this being for 24-hour power, or 8766 hours per year. It was stated by Mr. Peter Wright that these prices were for a minimum of 10,000 h. p., but that the Carborundum company, a large consumer located a short distance away from the power-house, was to pay $20 per annum under their contract for 1000 h. p. This amount of power must be paid for by the consumer, whether used or not. In manufacturing industries generally the power is employed only 10 hours per day, or, say roughly, 3000 hours per year. Dr. Emery pointed out that, figured on this basis, $18 per h. p. per annum at the terminals of the Niagara dynamo would be equivalent to 0.6 cents per h.-p. hour leaving but 0.4 cents per h.-p. hour to pay the cost of interest, depreciation, administration, etc., of the step-up and step-down transformers, the transmission line, and the organization for local distribution in Buffalo, if the power is to be delivered at a price which will commercially compete with steam.

An anonymous writer in a technical journal has recently analyzed the problem with very much the same result. He says:

> The proposition of the Niagara Power Company is to sell a h. p. at the Falls for $10. If the city of Buffalo, or any one else, accepts this proposition, they must pay $10 for the h. p., whether they use it or not. They have the privilege of using it for 8760 hours in the year. What can it afford to sell this power for at Buffalo? Let us take the maximum efficiencies that actual practice, under favorable conditions, will give, and see how much of this h. p. we have to sell after transmission and distribution. We think no one will claim a *better* chain of efficiencies in actual practice than the following:
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> Efficiency of turbines, 80 per cent.; turbine shaft, 95 per cent.; electrical efficiency of dynamo, 90 per cent.; combined efficiency of step-up and step-down transformers and electrical transmission to Buffalo, 75 per cent.; efficiency of transformation from alternating current to direct current, 90 per cent. This will leave but 46.17 per cent. of the power we have bought to sell, and it has cost us $10, or at the rate of $21.66 per h. p., if used continuously. In electric-lighting stations the average consumption is rarely as high as 40 per cent. of the maximum; but let us assume that in Buffalo the average demand will equal 60 per cent. of the maximum. The maximum which we have to deliver is but 0.4617 h. p., but the average demand upon which we could rely would be but 0.277. This has cost us $10 at Niagara. Its cost at Buffalo is, therefore, at the rate of $36.10. If we allow an efficiency of 90 per cent. for distribution, it will cost $40.11 per h. p. But we have charged nothing for interest and depreciation on wheel pits, side canals, wheels, transformers, dynamos, or line; nothing for labor, attendance, and administration; nothing for expert advice, cost of experimenting, or interest on investments during period of installation; nothing for right of way, insurance on buildings, and nothing for interest on the investment for apparatus, etc., which the customer must make before the power delivered at his door

can become available, and which will be a factor with him in deciding whether he will become a customer or not.

Without attempting to enter into an elaborate computation of these additional items of cost, even if it were possible to estimate them with even approximate accuracy, we may say that the sum total will certainly exceed considerably the cost of locally-generated steam-power in Buffalo. While it is not at all unlikely that the average cost of steam power in Buffalo to-day may be 50 per cent. higher than the figure given by Messrs. Arnold and Emery, which may be taken at $31 per year, yet it must not be lost sight of that the electric power must compete, not alone with actually existing conditions, but with ne best conditions ordinarily attainable in every-day practice.

Mr. H. Ward Leonard, a well-known electrical engineer, in a communication to a technical journal some time since, said : "It does not seem reasonable to me that a manufacturer having a steam plant lready in operation will consider taking electric power, unless there is a saving of nearly 50 per cent. in the cost of power, for he must still retain his boilers for heating, and, as his engineer usually acts as machinist for all his machinery, he cannot save his salary by using electric power. In most industries the cost of power is not more than 10 per cent. of the cost of manufacture, and, if there be any considerable increase in the liability of failure of power, it will require a very great inducement in order to make the change to electric motors attractive. Furthermore, most manufacturers believe that they are producing power at about one-half to two-thirds the figures given by Emery's tables, and, although they are probably in error, it is their low estimate of their cost of production which must be materially reduced before the proposition to use electric power becomes attractive to them."

One of the most interesting of the many contributions to this discussion is that contained in a pamphlet issued by the veteran engineer, General Herman Haupt, late chief engineer of the Northern Pacific Railroad, who will be remembered as a pioneer in the construction of the Hoosac tunnel and of the Tidewater pipe line, the first successful attempt to pump oil from western Pennsylvania to eastern shipping points, and whose opinion in a matter of this kind is entitled to much consideration. While some of his assumptions respecting the transmission of electric currents at high voltages are not free from error, these are not of sufficient importance to vitiate his argument as to the commercial practicability of supplanting steam-power at Buffalo by electric power derived from Niagara Falls. General Haupt, however, goes much further than this ; he boldly takes the ground that the attempted employment of electricity for the distribution of power from

Niagara is an engineering mistake, and contends that the only economical and commercially feasible plan is that which depends upon the use of compressed air. The proposition to employ compressed air for this purpose is by no means a novel one. As long ago as 1860 the late Horace H. Day, who constructed the hydraulic canal at Niagara which has supplied power for a number of manufactories since that time, proposed to distribute the power in this manner, and he expended a large amount of time and money in experimenting near Bloomingdale, N. J., with compressed air machinery designed to carry out his purpose. It appears that, even so late as 1890, Mr. Francis Lynde Stetson of the Niagara company was advised by Mr. George Westinghouse that power could be transmitted from Niagara to Buffalo, not by electricity, but by compressed air. Mr. Stetson tells us that the matter received the most careful consideration at the hands of the international commission of engineers, and that the three leading pneumatic installations of the world were visited and examined,—*viz.*, the Popp system in Paris, in which 7000 h. p. is distributed by compressed air throughout that city, operating more than 30,000 clocks in the hotels and residences, and supplying refrigeration for the cold-storage warehouses, and an electric-lighting installation near the Madeleine ; the Sturgeon & Lupton system in Birmingham, England ; and that of the Chapin iron mine, at Iron mountain, Mich., in which the power is transmitted a distance of 7 miles. The efficiency of the Popp system is stated to be only 38 per cent. and that of the Birmingham system 52 per cent., both for comparatively short distances, and for this reason, Mr. Stetson says, "it did not seem wise to the Niagara Falls Power Company to adopt this system, useful and valuable as it is in many particulars."

The observations of General Haupt in this connection are of interest. He says in his pamphlet :

> An eminent financier recently remarked to the writer that he had no faith in the use of compressed air as a means of transmitting power : that it had been fully tested in Paris, and had proved a failure, and that great losses had been sustained by the investors.
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> The reply was that no one had a right to expect success where the essential conditions have been violated. All attempts heretofore at power transmission, so far as known, have been at low pressures of from 100 to 200 lbs. per sq. in., but the loss of power in transmission, with a given weight of air, under 200 lbs. initial pressure, is ten times as great as if the pressure were 2000 lbs. To use steam power to compress air, transmit this air through pipes at a low pressure to a distance, and use the air cold to drive dynamos to generate electricity in competition with power generated locally by the use of coal, would be the height of folly, and no better results would follow from the similar use of electricity as the medium of transmission ; but, if air can be compressed by the power of a waterfall, for which there is no other use, and transmitted at an initial pressure of 2000 lbs., and reheated before use to double its efficiency, then the

essential conditions of success will have been complied with. These conditions do not appear to have been recognized; failure was a necessary consequence, and the discredit of failure should not attach to the principle of air transmission, but to the defective manner of its application.

It has been assumed that only one-half of the power expended in compressing air could be recovered in the subsequent expansion of the air in doing work, and that much loss was sustained by friction in pipes, where transmitted to long distances.

On the contrary, it can be conclusively demonstrated that the power actually utilized in foot-pounds in the cylinder of a motor is largely in excess of the power expended in compression, and that air, under high tension, can be transmitted to very long distances with no diminution whatever in the amount of work that it is actually capable of performing.

He then enters into a computation based on the results of the experiments of the scientific commission at the Mont Cenis tunnel, showing that 2500 effective h. p. can be transmitted through a 6-inch pipe for a distance of 100 miles with an initial pressure of 2000 lbs., and a terminal working pressure of 147 lbs., with no loss of efficiency in the transmission, since pressures in excess of 150 lbs. cannot be utilized, and the friction of the pipe is merely a substitute for the reducing valve.

A comparison is then made of the cost of power thus transmitted with the cost of locally-generated steam power.

The cost of a line of 100 miles of 6-inch pipe will be $400,000, the interest on which, at 5 per cent., is $20,000.

To furnish 2500 h. p. of air will require 12,120 cu. ft. of free air to be compressed per minute, and the cost of compressor plant will be $110,000, the interest on which would be $5500. To this must be added for repairs and labor $7500, making a total of $37,000, or $13.20 per h. p.

The price proposed to be charged for power at Niagara at the shaft of the turbine is $13 per h. p., and, if the same allowance be made for water power in other localities, if used to compress air, the cost of power delivered at the end of the 100-mile pipe will be $26.20 per h. p. per annum.

At the Buffalo city water works, with engine capacity of 3600 h. p., the average cost of steam power is given at $77.55, and at Milwaukee water works at $75.83, but this includes, not only the boilers which generate the steam, but also the engines by which it is applied.

The cost of boilers alone, at $25 per h. p., would be $62,500; the interest, $3125; depreciation and repairs, $6250. If, as an average for most localities, 3 lbs. of coal be allowed per h. p. per hour, at $4 per ton, and 300 days of 12 hours to the year, the annual consumption of coal would be 13,500 tons, at a cost of $54,000.

To this must be added wages of firemen to handle 45 tons of coal per day,—say six firemen at $1.50 per day, making the cost of steam-power delivered from boilers—

Interest on cost of boiler plant	$ 3,125
Depreciation and repairs	6,250
13,500 tons of coal @ $4	54,000
Wages	2,700
2,500 h. p. @ $26.40 per h. p.	$66,075

This computation will show a slight difference at a central distributing station in favor of compressed air transmitted 100 miles, assuming the cost of water power to be equal to the proposed charges at Niagara. If the cost of distribution be taken into consideration, the difference would be in favor of steam, and 100 miles would therefore appear to be the limit of economical transmission of power generated from waterfalls at Niagara prices and transmitted by compressed air; but there are some other considerations of a very interesting character that will be presented.

Mountains of refuse coal lie at the mines, which, with properly-constructed boilers, might be burned, and become a source of power in the generation of steam. The cost of such steam, produced at the mines, would be the interest and repairs of plant and wages of firemen, the coal costing nothing. These items amount to $5 per h. p., as against the $13 proposed to be charged at Niagara for water power at the turbine shaft.

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[The foregoing article was left unfinished at the time of its author's sudden death. It has since been completed, however, by his brother, Mr. Ralph Wainwright Pope, and this completion is given below.—The Editor.]

The sad circumstances under which the writer has been called upon to complete the above article, to which his late brother had given such earnest thought, constitute his only excuse for undertaking a duty which no hand or brain but that of the author could properly perform. The Niagara Falls plant embodies a combination of those branches of engineering with which the late Mr. Pope was most familiar by natural taste, professional practice, and lifelong study. There is probably not another undertaking under discussion to-day to which he would more naturally turn his attention. The boldness of the conception; the massive construction; the conscientious effort to attain the best results in every particular,—were all of a character to appeal to his broad and cultivated mind; therefore, as one confronts the vacant page upon which were to appear the conclusions he had arrived at, there arises a feeling of incompetence to grapple with the subject as he, with his thorough mental equipment and judicial training, would have done. The question of undeveloped water power was a most familiar one to him, and, possibly for this reason, he recognized at an early day the important field awaiting the future application of electrical transmission of power. Since boyhood he had been familiar with the water powers of the Housatonic river. Like many others, he had possibly wondered why Falls Village, Connecticut, had not become a second Lowell, Lawrence, or Manchester. There was Canaan Falls, with its completed canals waiting year after year for the wheels, the mills, and the spindles which never came. There was also that locally-famous power in the town of Stockbridge, occupied perhaps 40 years ago by Algier's furnace. Buildings as well as dam had crumbled into ruins within his recollection. Something was evidently lacking; else this mighty force of falling water, existing in hundreds of other locations, would be brought to the assistance of man in his continual search for cheap sources of power.

As a triumph of engineering skill, the Niagara Falls tunnel, with its hydraulic and electric plant, is a work which no man could more heartily appreciate than the late Franklin Leonard Pope. Here, he might well say, is an investment of $5,000,000, a practically everlasting monument to international engineering skill. Upon this plateau, extending for miles to the eastward of the power-house, may be built the ideal city of the world. From its developed 100,000 h. p. may be derived whatever energy is necessary to turn every wheel, to light and heat all private and public buildings, and to weld, forge, or smelt whatever metals may be brought to the locality. Here may yet be seen a city without smoke ; a city with an inexhaustible supply of pure and wholesome water ; a city with a perfect system of drainage ; a city bearing the name already known wherever the pen and the printing press have told, and the mails have distributed, the story of Niagara. Throughout the 5 long years occupied in its construction there has existed a definite idea as to the future of the undertaking. The mere fact that the problem of transmitting power to Buffalo, or to Albany, or even New York city, has been discussed does not prove that such a scheme is contemplated. In fact, it has been an ideal question for debate, owing to the elasticity of the various opinions which have been passed upon it. Is there any reason why the Cataract Company should be desirous of finding a market for its energy in Buffalo? It does not appear to the writer that the occasion has yet arisen. The true field for power distribution lies within a radius of 10 miles of the power-house. Are the inducements offered sufficient to attract to Niagara the necessary aggregation of industries to practically utilize the power soon to be available? It is just at this point, that a question of doubt arises in the minds of those who have studied this interesting question in all its bearings. What was originally an engineering and financial problem becomes now more complex, embracing, as it does, various commercial, economic, and even social phases. The cost of power in itself is subordinated by other factors in certain lines of manufacturing. Established industries, especially those which are now being conducted with profit, are not disposed to make a radical change in location, unless sufficient advantages are offered to outweigh whatever expense and inconvenience might arise therefrom.

Again, there are comparatively few industries in which the item of power is a large percentage of the total cost. Among these are notably the very establishments which have already contracted for power, and are now in operation, deriving their energy from the Cataract plant. One of these, a paper mill, absorbs about 3000 h. p., using its own turbine, and is said to be the largest establishment of its kind in the country. The manufacture of paper requires not only a large amount of power, but also an ample supply of pure water. Wood pulp now enters so largely into the composition of paper that proximity to vast forests is also a factor of great importance. Should experience prove that paper can be manufactured at Niagara Falls more cheaply than elsewhere, new mills may be established, while those now in existence elsewhere will continue in competition under the changed conditions probably for years to come. When the Holyoke water power was developed about 40 years ago, Lee, Massachusetts, was the most important paper-making centre. Gradually, however, Holyoke forged to the front under more advantageous conditions, one of which was cheaper and better transportation facilities. Lee has failed to maintain its supremacy, although paper-making is still its leading industry. The production of aluminium and carborundum at Niagara are new industries, although both are instances of removal from a distant city (Pittsburg), which has long been considered a most desirable manufacturing location. The existence of cheap fuel at that point, in spite of which these concerns have made this significant change of base, would seem to indicate that Niagara will afford great advantages to large power consumers. It is quite possible that in each of these cases special inducements may have been offered in order to stimulate the demand for power.

A recent editorial in *Electric Power* calls attention to a possible development of large power consumption in a comparatively new field in the following words: "We believe that electro-chemical processes will increase to such an extent that a very large part of the power now developed can be disposed of to them, and that chemicals now imported at high prices from foreign countries, where power is small but labor cheap, will be made here at much lower prices by means of the cheap power at Niagara Falls." If the interests of the affiliated Niagara companies were confined to the simple production of power, the best possible market for its sale would be sought, whether far or near. As large landholders in the vicinity, however, the prospective increment in real estate values assumes importance to them. It is well understood that the surrounding territory is a region of cheap coal; therefore the economic problem of electrical transmission is quite different from the conditions existing where installations covering distances of from 15 to 20 miles are in commercially successful operation. In ordinary practice, however, Mr. H. A. Foster* has found that, in eleven different establishments in Buffalo, the cost of steam per h. p. per annum ranges from $32.70 to $233.95. The total power included in this report is 6300, or about one-tenth the estimated total power used in that city, according to Lieut. S. Dana Greene. It is evident, therefore, that the high efficiency claimed for the best steam plants is seldom attained in ordinary practice. If the existing plants in Buffalo were so grouped that they could readily be served from centrally-located power stations operated at the highest efficiency, no doubt a considerable saving could be effected. The question of location and convenience, however, necessitates the present arrangement; therefore the flexibility of electrical distribution might lead to the substitution of the motor for the steam engine in many cases where the question of heating and the use of steam in manufacturing was of little importance.

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* *Electrical Engineer*, June 26, 1895

It is not always safe to base important plans upon possible economies, unless a clear case can be proved. Assuming that power may be distributed in Buffalo electrically at $40 per h. p. per annum, ten of the establishments noted by Mr. Foster might save the following sums yearly: $5500, $2400, $8800, $7760, $4200, $5460, $3330, $2200, $2040, and $2660. In one case only, where the cost per h. p. is given at $32.70, would the result be in favor of the existing plant, to the amount of $10,220.* When confronted with figures similar to the above, a competent consulting engineer would perhaps be called in, and under his professional advice a saving probably might be effected in some cases, which would lead to the same result while still retaining the independent power. The differences are frequently due to the conditions of use rather than improper management. The question seems to hinge almost entirely on the cost of local distribution, and it is just at this point that the project of electrical transmission to Buffalo has come to a halt. The power company has fixed its rates at the power-house, according to various authorities quoted, at $10 per year for undeveloped power, $13 at the top of the shaft, and $18 at the dynamo terminals, evidently laying aside for future consideration the rather complex problem of meeting the requirements of miscellaneous consumers at a distance. As it stands to-day, the Niagara Falls enterprise is similar to enterprises which have already proven successful at Lowell, Holyoke, and Paterson, except that it is on a much larger scale. All new manufacturing enterprises in this country, unless of a strictly local character, will doubtless be located hereafter, only after thoughtful consideration of the great advantages at Niagara.

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* It is understood that all contracts for power are based by the Cataract Company upon the maximum which may be reached at any time by the consumer.

EDUCATION OF MECHANICAL ENGINEERS.

AIM AND SCOPE OF THE ENGINEERING COLLEGES.

By R. H. Thurston.

ENGINEERING schools of the higher class have now come to be grouped among the professional schools, which once included only law, medicine and theology. In fact, as President Jordan has remarked, they are coming to represent the highest and most exacting of all grades of professional work, and the young engineer-novice, graduating from a first-class engineering school, has gone through a severer ordeal, has been given a sharper discipline, has acquired more of fact and real learning, in the course of his 4 years of steady and arduous application, than is given, or can be given, in the best existing schools of the older types. His course of instruction demands, frequently, if not usually, higher work in preparation; it is longer by from 1 to 3 years; it involves more severe labor in mathematics and in the physical and applied sciences; and includes, as a rule, as much, if not more, linguistic study. Competition is sharp, in the professional school and outside it; and the elimination of the ill-prepared and unfit is merciless. Few men enter the profession of engineering through such schools, except after 4 years or more of hard work, or unless possessed of some talent for the chosen field of life-work. The drones, the naturally incompetent, and the dissipated are weeded out of schools of this class with far greater effectiveness than from any other professional schools*; and the same is in large degree true of the professional societies, entrance to which is always considered important in later years. It may be fairly claimed that, although often narrow, and perhaps even narrowing, the engineering education of to-day, and in the best class of schools in the United States, is representative of the highest work performed in professional schools, and that the young engineer leaving these schools is a better-trained man, professionally, than the graduate of any other professional school. He also possesses a more extensive and practically useful knowledge of the physical and mathematical sciences than any other, and usually has a better hold upon scientific methods of practice, and is more familiar with all the arts subsidiary to his profession. Laboratories and workshops afford him the opportunity to learn his profession by its practice in these departments. His "clinics" are even more varied and helpful than are those of the medical schools.

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* Of the candidates admitted to the best engineering schools, often not more than one-third finally graduate.

The mechanical engineering school confines itself, as nearly as may be, to purely professional instruction in that branch of the profession and its introductory and subsidiary departments. The point at which it shall begin its work is very generally dependent upon the character and the curriculum of the preparatory schools from which its students must be drawn, and its work begins where theirs ceases,—with the higher mathematics and the natural sciences in their special applications. What is desirable in its curriculum is a question to be settled finally by the profession at large; what is practicable is determined by its faculty and the preparatory schools. That school is best which most nearly reaches such a position as enables it to comply with the demands of the profession, and this, in turn, means that which makes the largest demands upon candidates for admission; for no engineering school has yet reached such a position that it can confine itself absolutely to professional work. The proper scope of the professional school, in engineering, is that which sends out its graduates versed in all the fundamental principles of the sciences and all the technical applications of mathematics, physics, chemistry, and mechanics which find general use in the art of engineering, together with such practical familiarity with the subsidiary arts as will enable the young man to enter his chosen profession well-equipped with all that is needed to give him prompt introduction into real work and to prepare him to solve every scientific problem which may arise.

The best-equipped schools of mechanical engineering, for example, carry their students through the usual college work in mathematics, the natural sciences, and the modern languages, into those higher departments of applied science which constitute the theory of all engineering, and into practical, systematic, carefully-planned work in the chemical and physical laboratories, in the newly-inaugurated "mechanical laboratory" of "experimental engineering," in draughting rooms, and even in workshops of the major trades. The backbone of their scientific work is a strong course of instruction in applied mechanics in their junior, or even, as in the course supervised by the writer, in their sophomore year, which study gives solid foundation for the laboratory work, in physics, in chemistry, and in engineering, of the junior and senior years of a 4 years' course. In these schools, the ordinary college course in science is simply a beginning, and the student must be carried forward and upward into the higher realms of experiment and research.

Every important school of mechanical engineering now gives instruction in mechanical drawing, and in shopwork, four years, uninterruptedly. The purpose and the result are the acquirement of practical skill in the use of the tools of the profession and of its subsidiary trades, and the ability to apply the exact methods of the laboratories of science to the solution of every professional problem met with in their application in professional work.

In a well-equipped school and with able teachers the progress of the young man who is naturally suited to the work is extraordinarily rapid and fruitful. Even in the instruction in manual training,—now a generally important division of the work,—the student, under the tuition of an expert, and following the systematic course laid out for him, becomes singularly expert in a wonderfully short time. The equivalent of a few days' work makes him a good smith, and he welds iron with facility and certainty ; the equivalent of a few weeks' work at the anvil makes him a good worker in steel, and he makes and tempers his own tools with entire success. In the foundry he quickly learns the principles of his art, and it becomes difficult to find a pattern that he cannot handle. In woodworking and machine-shop practice he quickly learns to handle tools with the ease and skill of an "old hand." All this is done, not to make him a good mechanic in the usual sense, or to teach him a trade, but to enable him to design intelligently, to criticise good and bad work, to indicate the best methods of doing the work directed by him, and to guide the workman intelligently. Nevertheless, this knowledge and skill come into use in numberless cases in which the young engineer finds himself unable to secure the aid of a skilled workman. One young man writes me that he has just saved hundreds of dollars, at a western mining town, by welding up a broken valve-stem that must otherwise have been sent hundreds of miles and caused days of delay ; another tells of his successful readjustment of the steam-distribution and the speed of an engine, with the result of securing a doubled power and consequently doubled output of a stamp-mill, in a location where it was thus possible to increase the earning power of the establishment by many thousands of dollars every year.

The mechanical engineering school has thus come to be, not only extensive in its curriculum, exceptionally high in grade, and exceedingly exacting in its requirements, but enormously costly in equipment and in operation. The larger and higher of these schools usually operate, as a piece of scientific apparatus, an "experimental steam-engine" representing $10,000 or $15,000 and working up to perhaps 200 h. p. in some cases, and costing large sums daily for its operation. In an inventory under the hand of the writer are listed fifteen engines of various classes—and more are said to be needed. To-day an independent school can hardly make a beginning in this field with less than $1,000,000. Even if connected with an existing university under satisfactory conditions of mutual help, $500,000 will hardly satisfy the demands which it is intended to meet ; and, when graduate schools of special departments, as of marine, of electrical, and of railway or textile engineering, are to be sustained, $5000 to $10,000 a year, each, must be further provided for their support.

The costs to the student are, of course, a minute fraction, usually, of the total costs of operation. The school pays out from $300 to $500 per student, if of the highest grade ; the pupil is charged from $200 down to zero, in different schools, for his tuition and costs of material. The State universities and their technical schools seldom make any charge, and, aside from tuition fees, there is a wonderful variation in the expenditures of students. One student waits on table, takes charge of furnaces in the neighbors' houses, or otherwise earns a few dollars weekly, and, living on oatmeal, with a little canned meat, and doing his own cooking on an oil stove in his garret-room, lives and works hard on from $100 to $200 a year. The son of people of moderate means expends $500; the well-to-do young man from 50 to 100 per cent. more ; while the foolish son of more foolish, but wealthier, parents spends from $1000 to $3000 or more, mainly on his follies. Number one of our list usually forges ahead, and stands, ultimately, in the front rank in the profession. The last-mentioned youth either drops out of his class, or, later, lounges at the foot of the ladder, while his perhaps despised rival climbs to the top.

A broad and liberal education, and even a classical education, has its value, professionally as well as in the making of the man. On reaching a certain point in his professional career, other things equal, that man who can best meet intelligent and cultured men on their own level secures the highest and best professional line of practice. Social qualities, intellectual ability, solid learning, are effective reinforcements of the business side of life. James Watt was not simply a great inventor and a great mechanic ; he was a learned man and a companion of the great men of his time in every department. His professional success and, more important still, perhaps, his beautiful private life and the glory of his later years, were largely based upon his social and intellectual attainments. "*Wisdom* is the principal thing ; therefore get wisdom : and, with all thy getting, get understanding. Exalt her, and she shall promote thee : she shall bring thee to honor, when thou dost embrace her."

"The aim of engineering schools" is to offer to intelligent, ambitious, well-prepared young men, who have a talent for the profession of engineering,—and to none other,—such a system of special instruction, of elementary professional training, and of practice in the application of scientific principles and methods in the essential branches of the arts and trades contributory to professional work, as will enable such youth to successfully enter, and to make easy and rapid progress in, the chosen field of life-work. The best of such schools are to-day bringing all the arts, all the sciences, and all the literatures under contribution, in so far as each and all may be found valuable, in the promotion of what is coming to be one of the most truly learned, if not actually the most learned, of all the professions. Old as Tubal Cain; distinguished by a membership including Hero and Archimedes, Da Vinci and the second Marquis of Worcester, and a thousand later and no less great men; advancing as is no other profession to-day; contributing to the promotion of the comfort and happiness of the world as does no other department of human labor and thought,—this profession is now coming to possess the means of training its youth up to a higher standard than is, or ever was, attained by any other profession, and it is doing, more and more, the work of the world. In this great field, and to these great ends, the schools of mechanical engineering are to-day contributing most magnificently. Future years will see, it may well be hoped and believed, even more admirable work performed in the building-up of the industries, in their diversification, in promoting the physical and moral welfare of the people, and in giving the nation prosperity, power, unity, and noble aims.

EDUCATION OF MECHANICAL ENGINEERS.

II—THE BEARING OF SHOP PRACTICE.

By Charles E. Emery.

A MAN'S success in life depends, first, on his natural ability, and, second, on what he knows. An able man may start with practical work, and by industry and earnest endeavor rise through the various grades, become useful, say, as an engineer, and afterwards supplement his education by hard study, when necessary, and attain some degree of eminence; but this will be accomplished with an enormous waste of time and energy. The success of so-called self-made men should not encourage deliberate attempts to repeat such experiences. Many such men have had opportunities, now rarely available, to engage in practical work which of itself taught valuable lessons. Some started their education before the technical school as now known was in existence, and obtained really a good preliminary education in the many excellent academies of the country, which frequently taught practical surveying at least, and thus started the young man in life fairly well equipped for one branch of engineering, when its duties were less exacting than at present. Other successful engineers entered the profession late in life, after having the mental training due to study and experience in another profession. Others, in addition to early experiences, had learned habits of discipline and the necessity of study in connection with practical experience in the United States navy.

Of late years the technical school has supplied all that can be desired in an educational way; but some young men to whom study has been distasteful refer to the success of self-made men as a reason for not entering the technical schools, and many, without proper guidance, start work in some subordinate position in a shop or surveying party, with the expectation that they will continue to study, or at least "get along as well as others have done," unaware of the difficulties that the older men had to surmount, and without realizing that they must rise in competition with educated men from the technical schools, many of whom, after a little practical experience, will be more desirable additions to the profession than themselves. The majority of those who abandon their studies never return to them. They become satisfied with such progress as they can make, establish a social position with a class of people of the same kind, and gradually drop out of sight. A few of marked ability may ascertain their own deficiencies and be able to throw off the fascination of real progress in actual work, prepare for and attend a technical school at a somewhat advanced age, and win success in the end.

It has been pointed out that the graduates of technical schools are, as a rule, not immediately as useful as men who have risen from the shops, and, without realizing how much more the educated man knows when he has been taught how to apply it, some critics have arraigned the whole system of technical education, particularly the order in which principles and practice are taught. Some have held that, after preliminary study of English branches in childhood, lads should be put at practical work with the expectation that, while so doing, they would appreciate their lack of general information and at a later period of life find the higher course attractive, as they would then intuitively apply the principles to their former experiences, and see the advantages to be attained in understanding more difficult problems. It was hoped that in this way the necessity of much of the exertion required to keep students up to their work would be avoided, and perhaps some time saved eventually in accomplishing a certain degree of instruction and experience. Experienced observers, however, know that few average lads would use their reason in this way.

All interested would probably agree that, if it were possible to double the length of a course and have the school in a large manufactory, principles and practice could be systematically combined so that the students would be fairly proficient in both. Now about the same time must be occupied, but in different places. As matters stand, it appears to the writer that there are decided advantages in completing the regular course of study in the technical schools in comparatively early life, and then blending the practical participation and experience which are necessarily part of an education into the professional practice which follows in due course. If there were no other reasons, it is sufficient to say that the earlier years of a young man's life should be spent, when possible, among gentlemen, where, in a circle of culture and refinement, even the deficiencies of home training would be supplemented, and the manner and bearing of the inchoate man become so firmly fixed that the rough external contacts of practical life would not change them.

So long as technical instruction is confined to a four years' course, the greater part of that period should be occupied in the study of principles. It is useless to talk about continuing study afterward, unless the principles are so thoroughly grounded that the higher developments are immediately understood in such way that they can be applied at once with advantage. Moreover, the experiences of earlier work will so occupy the mind that it will be impossible to continue study. The work in the technical school should not, however, be confined entirely to the study of principles. There should be combined therewith instruction in the rudiments of practical work, which can generally be introduced in such a way as to furnish largely the exercise and diversion of mind which is necessary to all students between their periods of study. The principal advantages that our ancestors of the stone age had over other animals was that reason enabled them to make tools,—first weapons for attack and defence, then implements for tillage of the soil. Finally they discovered how to make a fire, thus accidentally developing metallurgical work and thereby improving their tools, until, in short, as engineers, they wrought out civilization. The engineer of the present day should further advance civilization by learning the use of tools thus developed until he knows their possibilities in the hands of workmen. He should start with ordinary hand tools to increase his physical strength and steady his nerves, such as the cold chisel, the hammer, and the file ; he should ascertain the possibilities of the blacksmith's forge and the routine of casting metals. After attaining a fair degree of skill therewith, he will more readily appreciate the advantages of machine tools, and the danger is that he will become so much infatuated with them that other features of importance will be neglected. Ordinarily he should use the lathe until he can make an accurate fit, and other tools sufficiently to know the object of their movements and form a conception of their capacity in connection with inspection of work elsewhere. It is undesirable to go further and construct machinery for actual use or sale in connection with school work, for the simple reason that there is so much else which needs attention in the limited time available.

It is particularly essential that the student in mechanical engineering become a good draughtsman and be employed in actual design, after he has learned its principles and can properly provide mechanical movements to accomplish the particular purposes and distribute the metal of a structure so as to secure minimum weight and proper strength for the computed strains. It is to be regretted that very few young men from the schools have the taste for this branch that they should. It is really the foundation of progress in mechanical engineering. The mechanical engineer should also know the construction and purposes of the ordinary surveying instruments of the civil engineer, and have some reasonable skill in their operation. He should know, similarly, the details of electric machinery, understand how to use it with due caution, and be able to utilize its powers to the best advantage, and to keep it in order.

In every branch of engineering the developments are in the direction of more important mechanical structures, requiring the skilled judgment of a mechanical engineer. The locks of a canal are now being so much enlarged that they must be made of iron and steel instead of wood, and moved by powerful engines, hydraulic or otherwise. Railroads, railroad shops, and electric-power plants are now great hives of mechanical industry. The modern ship, whether for naval or merchant service, is contructed of steel or iron, requires for its propulsion immense steam engines and boilers, and has come to have all the modern conveniences of a great city in a single structure, such as refrigerating plants, electric lighting, artificial ventilation, etc. The modern buildings require frames of steel, high-speed elevators, and a great amount of machinery in the basement to operate the elevators, furnish electric lights, and keep up the water supply. It is impossible for the mechanical engineer to learn at school all the details of civil engineering work, naval engineering, electrical engineering, and architecture, but he may learn the principles which underlie all branches of engineering, and in a general sense what it is possible to accomplish with each, and so fit himself to design and superintend the construction of any mechanical structure in either of the departments named.

In addition to the above, it is desirable that an engineer should know something more than his specialty. He has duties to society and to his friends. The old saying, "know something of everything and everything of something," is valuable, but it is necessary for a man, not only to know his business thoroughly, but to be able to impress others with the fact. It is well for a technical man to have a superficial education like that of some women, in addition to his technical knowledge, and thus know how to be entertaining without exhausting one's life with details.

It is thought that engineers of all classes can receive the same education until near the end of their college course. Few young men know early in life what particular branch of engineering they will follow; so it is desirable that the principles and general information to be imparted during the first few years of the course should be adapted to all the branches. It would be of advantage to have all kinds of engineers know the use of tools to the extent previously mentioned. All classes could probably take the same course the first year, and in the second year become more familiar with the operation of the devices peculiar to the chosen branch. Later, combined relaxation, pleasure, and exercise out of the hours of study would be taken up with laboratory work, which, for a mechanical engineer, would include experiments on the strength of materials, and with steam and gas engines, pumps, and the various kinds of apparatus usually employed. The present method of writing a thesis on some particular work of a practical nature in regard to which proper details can be obtained is very valuable, and frequently men of the more advanced classes procure and record information of this kind which is valuable to their seniors in after years.

In conclusion, the mechanical engineer should let no opportunity slip to learn all that can directly or collaterally benefit him in the prosecution of different kinds of work. This suggestion applies not only to the period of a college course, but to the *quasi* apprenticeship to practical work which must follow. The enormous amount of detail which it is necessary to acquire in order to be proficient in one division of one branch of engineering makes it necessary above everything that the student make the best of his opportunity during his course in the technical school to obtain a knowledge of principles and their method of application, with general information in the way of reference to descriptions of works of a special kind, so that, whatever problem may be submitted in after years, the principles can be readily comprehended. A habit of close observation in the direction one wishes to practise will, with these precautions, enable the young engineer to be of advantage to others during the early part of his career, and to himself and his clients as soon as he undertakes business for himself.

EDUCATION OF MECHANICAL ENGINEERS.

III—VALUE OF THE MANUAL TRAINING SCHOOLS.

By A. E. Outerbridge, Jr.

> Lessons—through and by work—through and from life—are by far the most impressive and intelligible, and most continuously and intensively progressive, both in themselves and in their effect on the learner. Notwithstanding this, children – mankind indeed—are too much and too variously concerned with aimless and purposeless pursuits, and too little with work. . . . Experience shows that external physical, productive activity, interspersed in intellectual work, strengthens, not only the body, but in a very marked degree the mind in its various phases of development, so that the mind, after such a refreshing work-bath (I can find no better name), enters upon its intellectual pursuits with new vigor and life.—*Froebel's Education of Man.*

THE aim of education—especially technical education—should be, first, to provide a thorough, general training or groundwork in elementary principles, and then to develop individual talent, so that, when the student enters the workshop of the industrial world, this latent quality may have become energized.

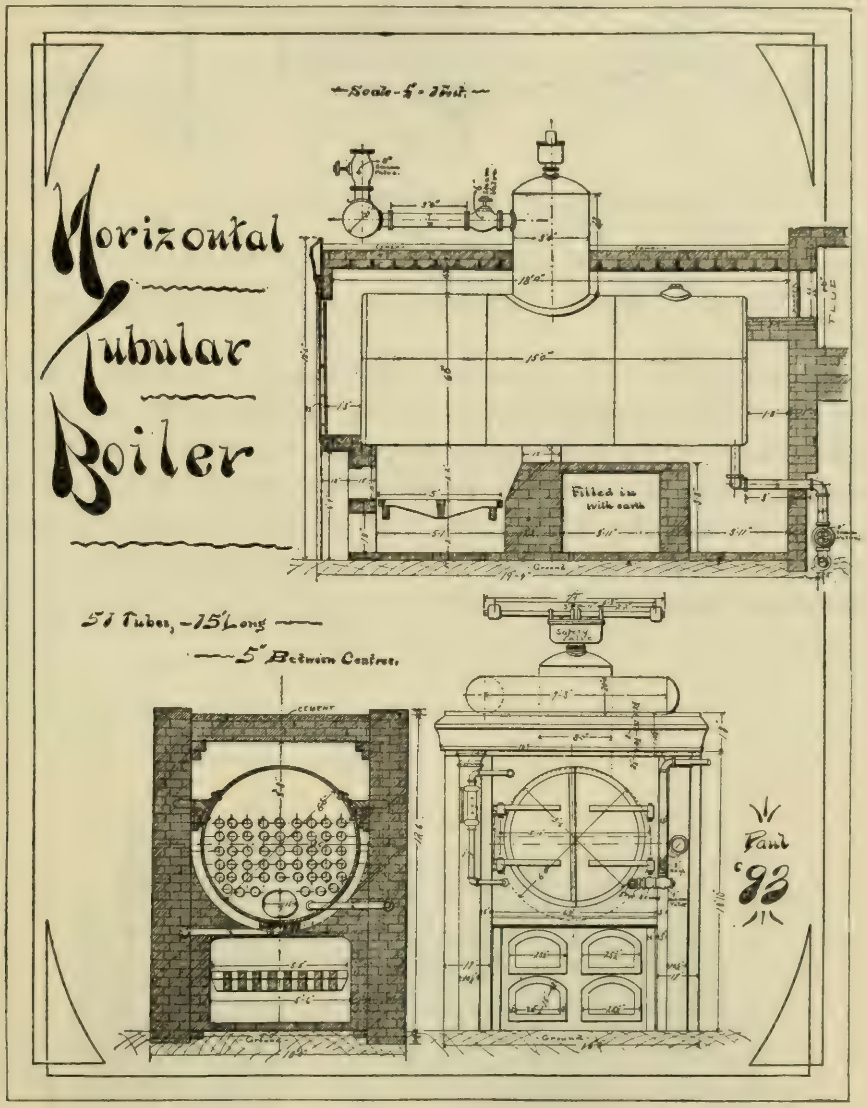
The evolution of the new conception of technical elementary education, to which the incomplete and misleading name of "manual training" has been given, has progressed with wonderful strides during the past few years, especially in America. Its history and the conditions and influences that have powerfully stimulated its growth in the United States is an interesting and tempting theme, but the limit of space allotted to me precludes my entering upon it.

Respecting the special topic which I have been requested to discuss in the ENGINEERING MAGAZINE,—*viz.*, manual training as a starting-point in the education of mechanical engineers,—I may say that I have heretofore contended that the aim of manual-training schools should be "to produce bright young workmen, not mechanical engineers; men, not officers."

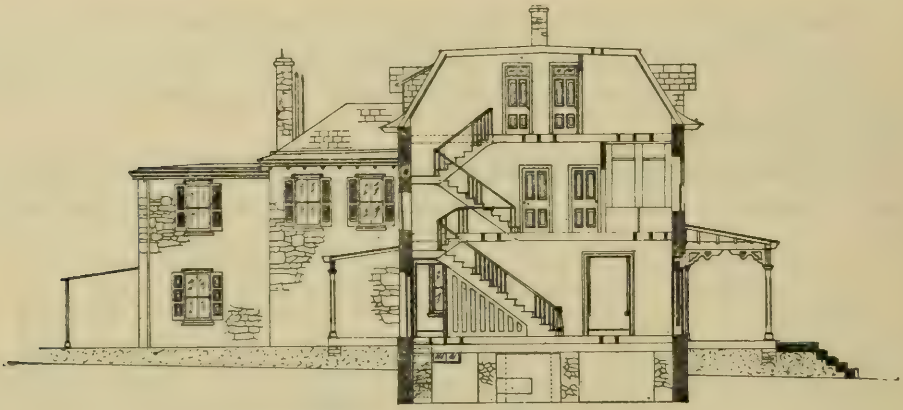
This view does not conflict with the arguments that I am now about to present, but harmonizes therewith, for the graduate of the manual-training school is, or should be, well fitted, by reason of the facile instruction he has received in practical manipulations and of the trend of his mental training, to begin the study of technical principles; not only has his hand become educated, but his eye has been trained and his mind developed along the line of his future calling.

As long ago as 1851 night schools for artisans were established at the Spring Garden Institute in Philadelphia, the teachers being draughtsmen and others from the Baldwin Locomotive Works in the immediate vicinity.

The famous Russian exhibit at the Centennial Exposition gave a great impetus to the study of manual training in the United States, and the mechanical handiwork schools of the Spring Garden Institute were soon afterwards established, on a modest scale, under the supervision of Lieut. Crawford of the navy. Girard College followed this lead, and in 1885 manual training was made an integral part of the public school system of Philadelphia through the establishment



MACHINE DESIGN. THIRD YEAR.

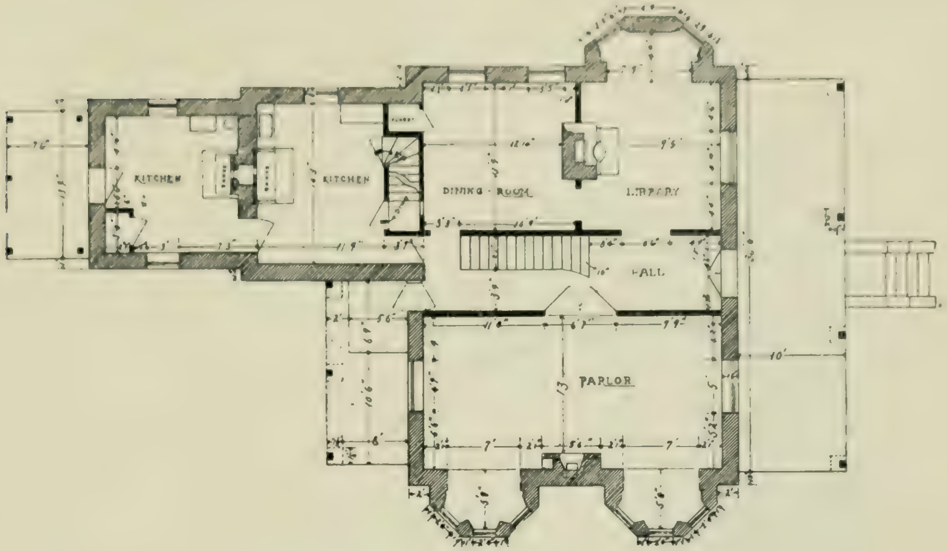


ARCHITECTURAL DRAWING. THIRD YEAR.

(under the auspices of a special committee of the board of education) of the "Central Manual Training School," having the grade of a high school.

Beginning with one hundred and twenty students, who were graduates of the grammar schools, it soon outgrew its quarters; extensive enlargements were made, and the entire plant was then duplicated by the establishment of the "North-East Manual Training School," of like grade and capacity, in a different section of the city. A plan for a grand extension of this successful experiment on a broader scope is now under contemplation. As the schools named are typi-

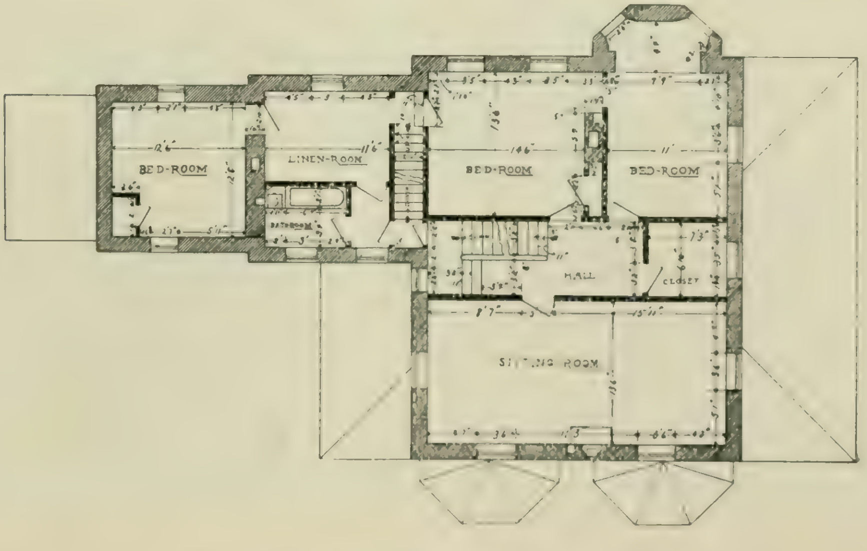
ARCHITECTURAL DRAWING. THIRD YEAR.



ARCHITECTURAL DRAWING. THIRD YEAR.

cal, and are essentially identical in equipment, the following general description will apply to either or both.

The faculty of the Central School comprises a principal and fifteen instructors upon the following subjects: mathematics; physics; chemistry and natural history; constructive, free hand, architectural drawing and designing; English language and literature; German and French; history and economics; joinery, turning, and parquetry; moulding, smithing, and ornamental iron work; chipping, filing, and fitting; pattern-making, turning, and wood-carving; constructive work, machine tools.



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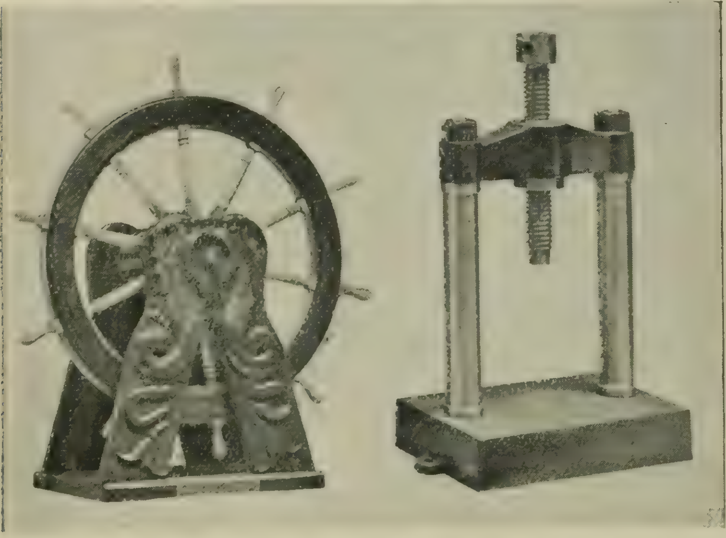
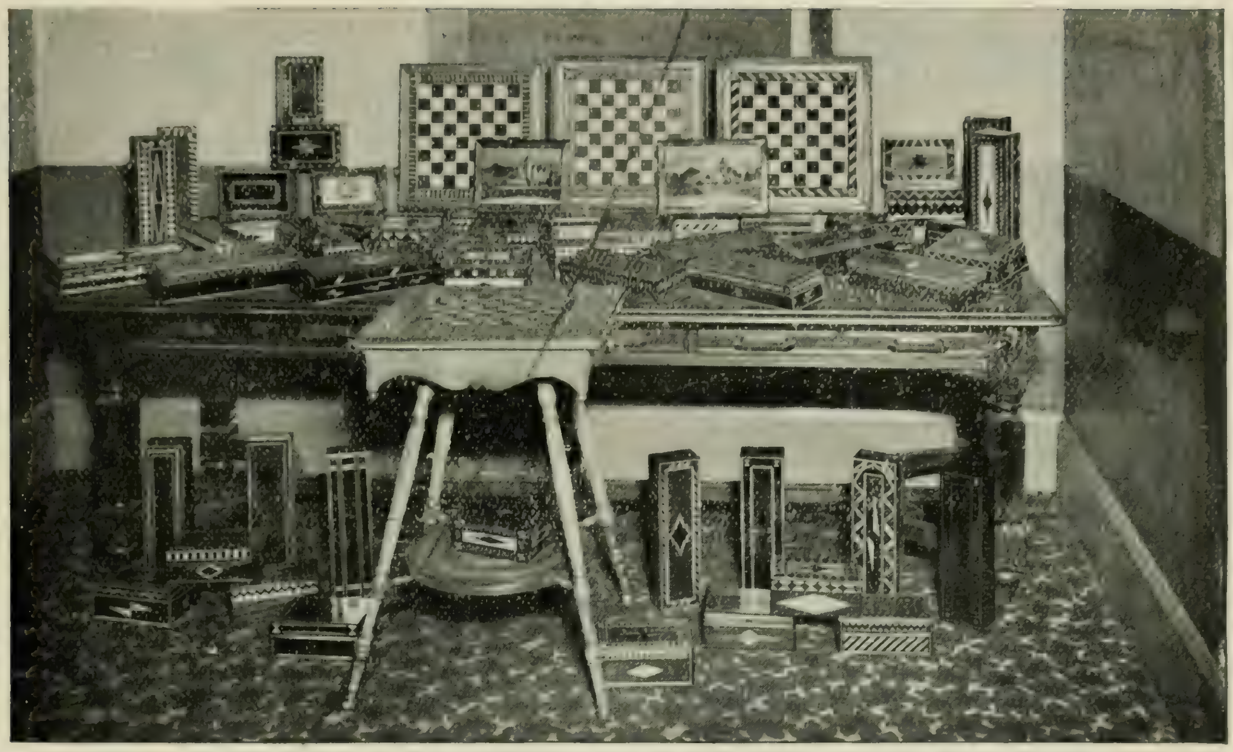


MECHANICAL CONSTRUCTION. THIRD YEAR.

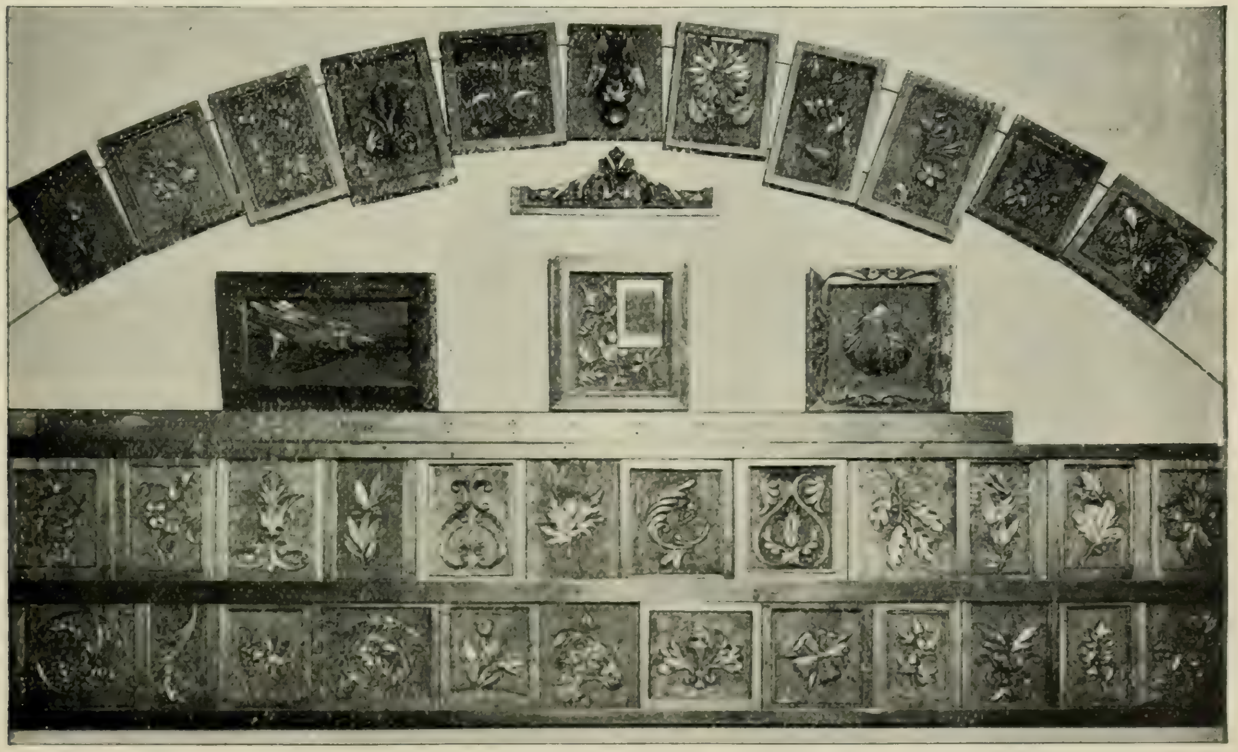
About seven hundred students now tax to the utmost the capacity of the two institutions; they are divided into classes of twenty-five, and, beginning with the draughting-room as the basis of the entire system, the students first make in note-books rough copies of simple mechanical designs. Working drawings are then made, and, when these are approved by the instructor, the boy constructs, in the course of a few weeks, his first "pattern" in wood from his own drawing, having received, in the interim, elementary instruction in the use of the chisel, plane, etc. When his pattern is approved, he makes a sand mould therefrom (having also, in the meantime, received instruction in the tempering of sand and the use of the moulder's simple tools). When he has successfully moulded the design in "green sand," he makes a casting of the same in metal; this must be free from "blow holes" and other defects known to founders. When the casting has been approved by the instructor, the boy passes into the "chipping shop," where he is taught the crude work of dressing castings with the cold chisel and file, cast iron and other metal practice-blocks being provided for the purpose.

MECHANICAL CONSTRUCTION. THIRD YEAR.

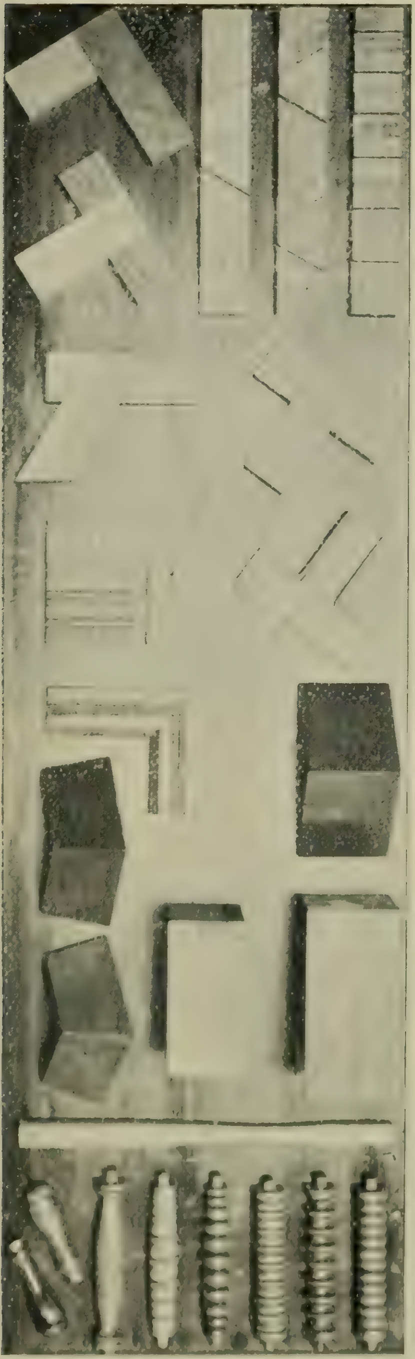
The standing of each scholar is graded by the record of his work,



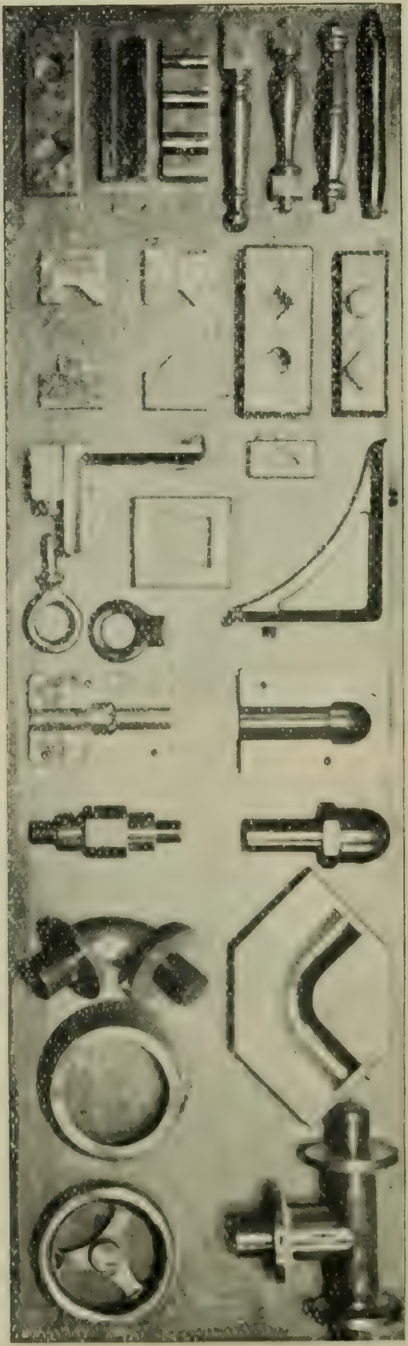
WOOD CARVING. FIRST YEAR. PARQUETRY.



WOOD CARVING. SECOND YEAR.



COURSE IN WOOD-WORK.
FIRST YEAR.



COURSE IN PATTERN-MAKING.
SECOND YEAR.

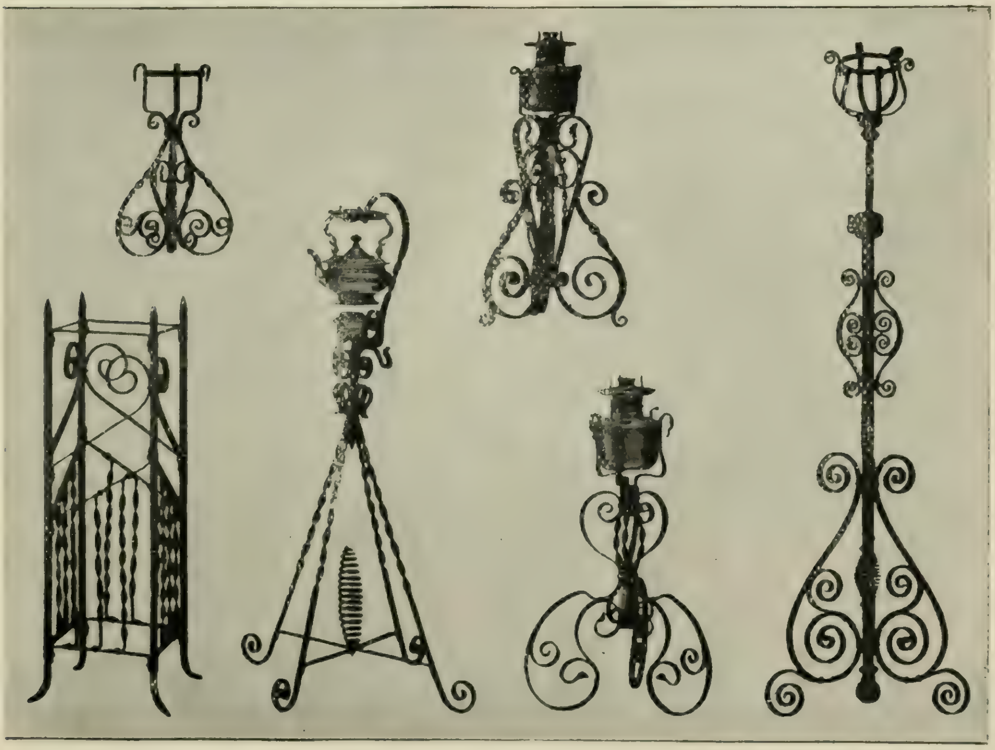
and a certain standard of excellence is required before the next step can be taken.

The course is of 3 years' duration, and, as the boy progresses, the operations become more difficult ; for example, the mechanical working drawing is more elaborate, because the pattern to be made therefrom is more complicated; the moulding requires more skill, because of the shape of the pattern, use of cores, etc.; and the machine work increases in complexity of detail in like measure.

It is not the intention to expend the time of the boys in manufacturing articles of use or ornament; they are taught principles and practice which will enable them in after life to apply knowledge to specific purposes. Many of the advanced students, however, have proved themselves competent designers and constructors of machine tools and other appliances, and a number of the tools in practical use at the schools were designed and built by the students.

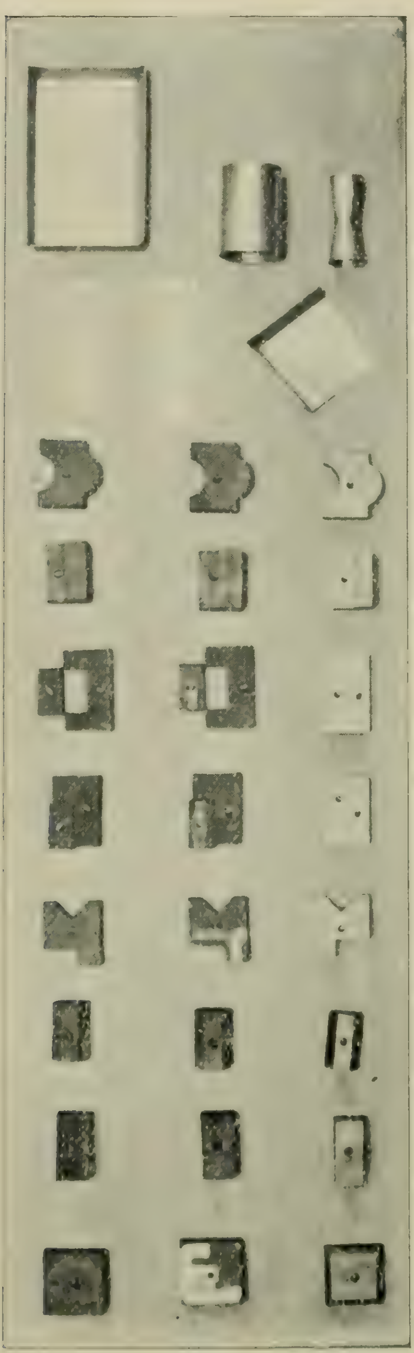
The literary feature of the curriculum is not dwelt upon here. Suffice it to say that in the academic department the method of study and research is made to harmonize with scientific principles, the effort being "to lay a broad foundation upon which the best superstructure of intellectual cultivation can be built." More hours per week are devoted to literary and theoretical study than to practical work.

Diplomas are granted to students who have successfully finished the 3 years' course; these admit the graduates to the University of



ORNAMENTAL IRON-WORK. SECOND YEAR.

This is some of the boys' work which they may own upon their paying for the material used.



COURSE IN CHIPPING, FILING,
FITTING AND TIN-SMITHING.
FIRST YEAR.

COURSE IN
SMITHING AND MOULDING.
SECOND YEAR.

Pennsylvania and other institutions of like standing without further examination. Prize scholarships are also granted by the University, providing free tuition to manual training school pupils having the highest averages.

That the school fosters a desire for higher education is shown by the fact that more than 25 per cent. of the graduates are students in colleges, universities, or technical schools, and about 70 per cent. are engaged in pursuits in which a high order of intelligence, as well as manual skill, is required.

A recently-prepared list of graduates with their occupations show that thirty-four are now serving as managers, superintendents, and foremen of electric power and lighting plants, manufactories, etc.; sixteen are teachers in manual training and other schools; thirteen are electrical engineers; seven are mechanical engineers; ten are architects; six are civil engineers; five are physicians; five are chemists (with steel works, etc.); fifty-four are draughtsmen; forty-five are engaged in various kinds of electrical work; and seven are law students.

In considering the question whether manual training, such as that afforded to students at the schools in Philadelphia, is adapted to the preparatory or more advanced education of the mechanical engineer, we must recognize the fact that this profession has broadened greatly within a generation, and shows an evident tendency to "specialization."

The training which sufficed both for the preparatory and the advanced education of the mechanical engineer 20 years ago is now inadequate. The sciences of electric lighting, development and distribution of electric power, and other practical applications of electric force produced by mechanical means, have been developed within the brief period named.

Modern improved methods of manufacture of structural iron and steel, and the application of these metals to the construction of buildings and other purposes, have caused a complete revolution, practically creating a new branch of mechanical engineering. Scientific filtration is a new science, and sanitary plumbing, disposal of sewage and garbage, and a host of other professional activities of equal importance and novelty now come within the required attainments of the mechanical engineer.

The fundamental principles which underlie the forces of nature are susceptible of simple demonstration, and these should be thoroughly taught, and are taught in the manual training schools; they are, in like manner, susceptible of practical elucidation through the aid of machinery. It is even possible to closely imitate the mysterious magnetic forces, and to illustrate their action by means of Professor Bjerkness's* pneumatic apparatus, which is unknown, I believe, in this country;

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* University of Christiania, Norway.

the idea of "mystery" should be eliminated in the study of nature's forces, and the student should be made to comprehend electric force as easily as he can comprehend mechanical force. The manual training school is aiming to do this, and the boy who winds an armature and constructs a model dynamo or motor has ever afterwards a degree of intimate familiarity with the nature of the forces called into play by the operation of the machine which no amount of theoretical or mathematical study can give.

The conclusion at which I have arrived, after study of the subject, aided by observation of the working of the Philadelphia schools, is that manual training, as a starting-point in the education of mechanical engineers, is a scientific invention and intellectual discovery worthy to rank with many other original discoveries of the age, and is destined to produce equally beneficial results in the future. It is, moreover, a discovery which has passed the stage of abstract discussion; the movement is rapidly taking firm hold in new localities, and enlarging wherever it has obtained a footing. Lest we might imagine that there is danger of overdoing the work, it may be stated that in Philadelphia,—the birthplace of manual training in America and foremost in its development,—the facilities of these schools extend to less than 3 per cent. of the boys in the public schools. Less than 1 per cent. of the school boys in the United States continue in school long enough to reach the grade of the high school; indeed, the percentage that attends even the grammar school is woefully small. Among other advantages possessed by the manual training school is the important one that it tends to prolong the school life of boys, and its expansion will prove of inestimable advantage, not only to the training of mechanical engineers, but in all walks of life.

THE INVESTIGATION OF PUBLIC WATER SUPPLIES.

By Floyd Davis.

ONE of the most important factors in the prolongation of life and preservation of health in any community is a pure and wholesome water supply. The necessity of measures which enable municipal authorities to secure such water, in quantities to meet all demands, is now fully recognized by every intelligent citizen, who also knows that pure sources of supply can generally be determined only by a thorough and careful investigation. As the population of our country increases, the sources of contamination likewise multiply; so year after year it becomes more and more difficult to secure an adequate supply of water for cities and towns that shall be entirely free from dangerous impurity. In mountainous regions, where the conditions for self-purification are most favorable, we generally find the purest waters, in great abundance; yet in the Mississippi valley, where the streams are generally sluggish and frequently heavily laden with organic impurity, and in the eastern States, where the rivers are sewer-polluted, the problem of securing pure water is difficult, and it is sometimes almost impossible with limited means to furnish a supply that is beyond dispute in its quality.

Many of our cities and towns lie adjacent to public water courses, from which the water, polluted or otherwise, is pumped through mains, without proper purification, to be drunk by the people. Under such a disregard for sanitary considerations it is not strange that we are still maintaining in some parts of the country a typhoid fever-rate higher than that prevailing in any other civilized country. Our typhoid death-rate is too frequently many-fold what it is in some European cities, like London and Berlin, which have expended millions of dollars to secure for their citizens a pure and wholesome supply of filtered water.

The ideal water for manufacturing and domestic purposes is distilled, and the amount of impurities, both inorganic and organic, found in natural water is, therefore, a measure of its purity. It is rare that the mineral constituents have any marked effect on the quality of a water for drinking, since the poisonous compounds of barium. iron, zinc, copper, lead, and arsenic, which may exist in it, are not often found in sources that are available for the supply of cities and towns; and in the sanitary investigation of a water supply we do not usually look for these substances. But the mineral constituents have a bearing upon the use of a water for boiler and manufacturing purposes. Its suitability for the generation of steam is determined mainly by the amount of lime, magnesia, and mineral acids which it may contain, since these bases incrust the boiler and the acids corrode it. Magnesium chlorid is especially objectionable. The mineral salts also characterize a water for manufacturing purposes, since a hard water containing much iron is unsuited for the manufacture of starch; a water having much magnesium in it is not desirable in the manufacture of beer; while water for distilleries should be as pure as possible.

These are considerations of importance only for particular purposes, but every public water supply must be used domestically by large numbers of people, and the substances which vitiate it for such purpose are of greatest importance in its sanitary investigation. They are organic, both vegetable and animal, and exist in different proportions in all natural waters that have any communication with the surface of the soil. The manner in which they gain access to water, and their relations to health and disease, have been discussed in a former number of this magazine.* Suffice it, therefore, to say here that decaying animal matter is indirectly far more dangerous than decaying vegetation, for it is from animal sources that the infectious bacteria, now considered the real agents of disease, are mainly derived. Upon the danger from these various impurities is based our classification of water supplies.

Whenever I am called upon to investigate the water supply of a city, which may include wells and other sources, I generally classify waters under five divisions, as follows:

1. *Excellent waters*, or those which are so pure and free from suspended matter that aëration and filtration would scarcely improve them. Aërated distilled water and the water from some springs in granite regions belong to this class, but it is rare that a chemist has to investigate them.

2. *Permissible waters*, or those which can be used constantly for all domestic purposes, without any danger of injurious effects. They are waters which, however, can be improved by better methods of storage, or by a thorough filtration. Nearly all drinking waters belong to this class.

3. *Suspicious waters*, or those which are liable at any time to produce ill-effects, or to become so polluted by an influx of filth that they may become bad, or even very dangerous. I always recommend that suspicious waters be first thoroughly boiled, and then filtered, before being used for drinking.

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* December, 1891.

4. *Bad waters*, or those which are sufficiently polluted to render them unfit for domestic use. These may not be immediately productive of disease, but I believe that they lower the vitality of the system and render it very susceptible of zymotic infection. On account of the nature of their pollution, common intelligence should prevent us from using them.

5. *Very dangerous waters*, or those which are polluted by direct communication with cess-pools or privies, and in which the pollution is of so high a degree that they should be immediately condemned. Such waters are often productive of typhoid fever and other filth diseases.

In passing upon the quality of a public water supply it is, therefore, essential that all water flowing into it which is seriously polluted with sewage should be rejected. There are other waters, not thus polluted, that have a disagreeable taste and odor, and are manifestly unfit for drinking ; still, they are sometimes used in public supplies, largely from necessity.

Cisterns and common surface wells are too infrequently used for public purposes to be considered here, and there are few or no apologies for such a supply in any wide-awake town, although from a sanitary standpoint they deserve our most careful consideration. Springs are used as a source of public water supply in many mountainous regions where the topographical conditions are favorable for their utilization, but in other localities ground waters, stored surface waters, rivers, and lakes are generally used. In many parts of Europe several of these waters are introduced into one city, sometimes at great expense. In this country the usual source is the one that is most convenient to adopt, which is somewhat determined by the topographical conditions of the locality. Thus Denver has a delightful water supply furnished by mountain springs and melting snow, supplemented by hundreds of artesian wells ; some cities, like Columbus and Des Moines, located near never-failing streams, utilize the ground waters in the adjacent gravel beds ; Boston and New York, having no adequate supply of fresh water near by, store in artificial lakes or reservoirs the rainfall on the nearest elevated water shed ; some cities, like Cincinnati, St. Louis, and Omaha, situated on rivers, secure their water supply from these natural channels ; while other cities, like Cleveland and Chicago, having great lakes at their doors, reach out into these for their waters.

Spring water which flows from subterranean sources is generally pure and wholesome, because from necessity it is free from organic contamination, and, when the springs are remote from the agencies of pollution, their water is certainly our most healthful beverage. It is so much superior to surface water for domestic use that some cities have incurred great expense to introduce it for a public supply, and in some instances have thus freed themselves of much sickness and a high rate of mortality.

Ground water in regions remote from habitations is generally very pure, and, although it may be, and often is, derived from polluted rivers, yet, owing to its thorough natural filtration, it cannot often be considered unwholesome. Indeed, with the exception of springs and some mountain streams, I consider ground water by far the best general supply for a city, and in the Mississippi valley this can generally be easily obtained. When such water is secured from wells and filtering galleries in beds of gravel above a city, or along a river course some distance from its channel, it is generally clear, sparkling, and nearly free from organic matter. This is especially true when the gravel beds are separated from the surface by an impervious stratum of clay, and the supply of water comes for long distances by filtration from rivers or other inexhaustible sources. Such water owes its purity to sedimentation and thorough filtration, combined with oxidation; for, during the passage of the water from its source to the well or gallery, the suspended decaying organic matter and the bacteria are retained in the soil, while the soluble organic substances are oxidized into harmless inorganic compounds. It is generally superior to artificially purified water, inasmuch as it is rendered pure long before being utilized, while surface water is purified as used.

Stored surface waters, rivers, and lakes may be very similar in their impurities. The former, when gathered on uninhabited water sheds, will contain little else that is harmful than decaying vegetable matter. But rivers are the receptacles of the waste products of the inhabitants of the districts through which they flow, and are sometimes very dangerous to use. When it becomes known that a surface water is in any considerable degree contaminated with the wastings of feed-lots and slaughter-houses, the refuse of manufactories, dead and decaying animals, and the drainage filth of many thousand square miles, it should be avoided; and, when it is further contaminated with sewage, or privy and cesspool drainage, or in any way mixed with the waste products of the human body, its use for drinking and cooking should be prohibited, for some of our most dreaded diseases are now traced to such water supplies.

My reason for rejecting all such water as unfit for human use depends also upon two other principles well-established in all civilized communities. The first is that common decency causes every intelligent person to rebel against the use of sewage-polluted water, for no one but a savage, or a lowly-organized scavenger, will wilfully devour the urine, excrement, washings, and filth of man and beast. That such filth is actually finding its way into many rivers is beyond dispute, for the many thousand head of cattle and hogs now kept along our western rivers during the feeding season contribute annually an immense amount of filth to these waters. Tramping the clay soil soon renders it impervious to the rains, and consequently nearly all the filth finds its way in rainy seasons through the small streams into these rivers. In time of high water, there is only little sedimentation of these impurities, and they are carried in suspension and solution down to and past the intake of water works of cities and towns located below. In time of low water much of the heavier suspended matter settles to the bottom of these rivers, there to decay and pollute the water, or to be washed down the stream at the next fall of rain.

The second principle is that, when a water has once become infested with disease germs, it can never be entirely purified, except by distillation or sanitary filtration. Such germs are liable to be contributed to these rivers at any time, should a sporadic case or an epidemic of typhoid fever occur in the drainage area above, and the dejections of the patients go into the river. The impurities in these river waters are such as will favor the multiplication and development of germ life, and the living organisms, instead of disappearing, sometimes become more numerous as the rivers are descended. During high water, when there can be no permanent sedimentation, these waters become constantly more impure in their flow down the river ; so, in using them as a source of supply, we must expect to be confronted with all the evil effects that can arise from the sewage and filth that go into them.

From whatever source a public water supply is derived, it should be borne in mind that it will not remain constant in purity throughout a whole season, for there are fluctuations depending upon rainfall, temperature, season, vegetable and animal contamination, and communication with other morbific agents. These variations and the probable degree of contamination of the public water supply should be investigated by the health officers, city physician, or other responsible and capable person, who should communicate his results to the people; and these investigations should extend to the surface wells and other sources of water, which the more ignorant and less fortunate classes are often compelled to use. It is a comparatively easy matter for one somewhat skilled in scientific manipulation to make a few qualitative tests that will enable him to determine with considerable accuracy whether or not a given water is badly polluted. For such examination I usually recommend two tests,—one for chlorine and the other for decaying organic matter.

In most parts of the country away from the sea and salt wells the purest ground and surface waters do not contain more chlorine than suffices to give, with a solution of silver nitrate, a faint opalescence. In testing water with this reagent, its action on a sample of known purity near by should be determined, to use as a guide in comparing other waters. And, whenever an experimental sample shows a decided milkiness with this reagent, then sewage contamination is to be suspected, in proportion to the amount of the precipitate; for sewage, dish-water, cesspool drainage, and other similar polluting agencies generally contain much chlorine. This test is also a valuable means of detecting drainage from a privy-vault into a well. It may be made by first determining the degree of opacity produced in the water by this reagent, and then throwing about 50 lbs. of salt into the vault, together with several barrels of water. After a few days, again examine the well water with a silver solution, and, if there is a noticeable increase of chlorine, contamination is quite certain, because the salt, which contains this element, has probably washed from the vault into the well. This method of testing gives results which will frequently surprise those unfamiliar with the subject.

Decaying organic matter is never found in appreciable quantity in pure water. If to a glassful of such water a few drops of sulphuric acid and a few drops of a dilute solution of potassium permanganate be added, a permanent pink color is produced; but, if the water contains decaying organic matter, then the pink color becomes fainter and finally disappears. In the hands of an expert this is an important test, but it cannot be relied on with a novice, since ferrous sulphate, hydrogen sulphid, and other reducing agents, sometimes present in water, produce similar results. But, when a water shows an excess of chlorine and bleaches potassium permanganate, it is certainly suspicious, and should be analyzed by an expert. My advice in all cases where persons seek counsel is to make the experiments given above, and, if the results are not satisfactory, to send the water to an experienced chemist, with necessary information regarding its source, and have a thorough analysis made.

The most extensive investigation of the quality of a water supply involves questions of a chemical, microscopical, biological, and physiological character, together with an examination of the surroundings of the source of supply; and in all this much depends upon the judgment and experience of the analyst, for water analysis is certainly among the most delicate of all chemical operations, and its proper interpretation requires great experience. The chemical analysis should determine the present and past pollution of water, and distinguish between vegetable and animal matter; the microscope should reveal floating substances, like fragments of hair, excreta, and other filth derived from surface drainage or sewage, which show at once that the water containing them is loathsome and unfit for domestic use ; the bacteriological investigation should be for the purpose of detecting infectious germs, but it is more frequently to determine the number of micro-organisms in a given volume of water ; while the physiological test should be made in order to afford opportunity for studying the effect of the water on the lower mammals. Since bacteria are now believed to be the direct or indirect agents of all zymotic diseases, the determination of the conditions favorable for their development, as shown by the chemist, or of their actual existence in water, as shown by the bacteriologist, is the real aim of sanitary water analysis. Without discussing the relative importance of the chemical, microscopical, bacteriological, and physiological examinations, it is only necessary to say here that, whenever a chemical and microscopical analysis reveals an excess of filth or sewage in a water, its use should be discontinued without further investigation ; for the time required for a thorough bacteriological analysis renders such too expensive for general use, to say nothing of the common failure to recognize the infectious germs. The most experienced water analysts look more to the chemical and miscroscopical results than to the bacteriological, because the chemical and microscopical methods of study are highly perfected, while the bacteriological methods are yet in a chaotic state so far as utility is concerned.

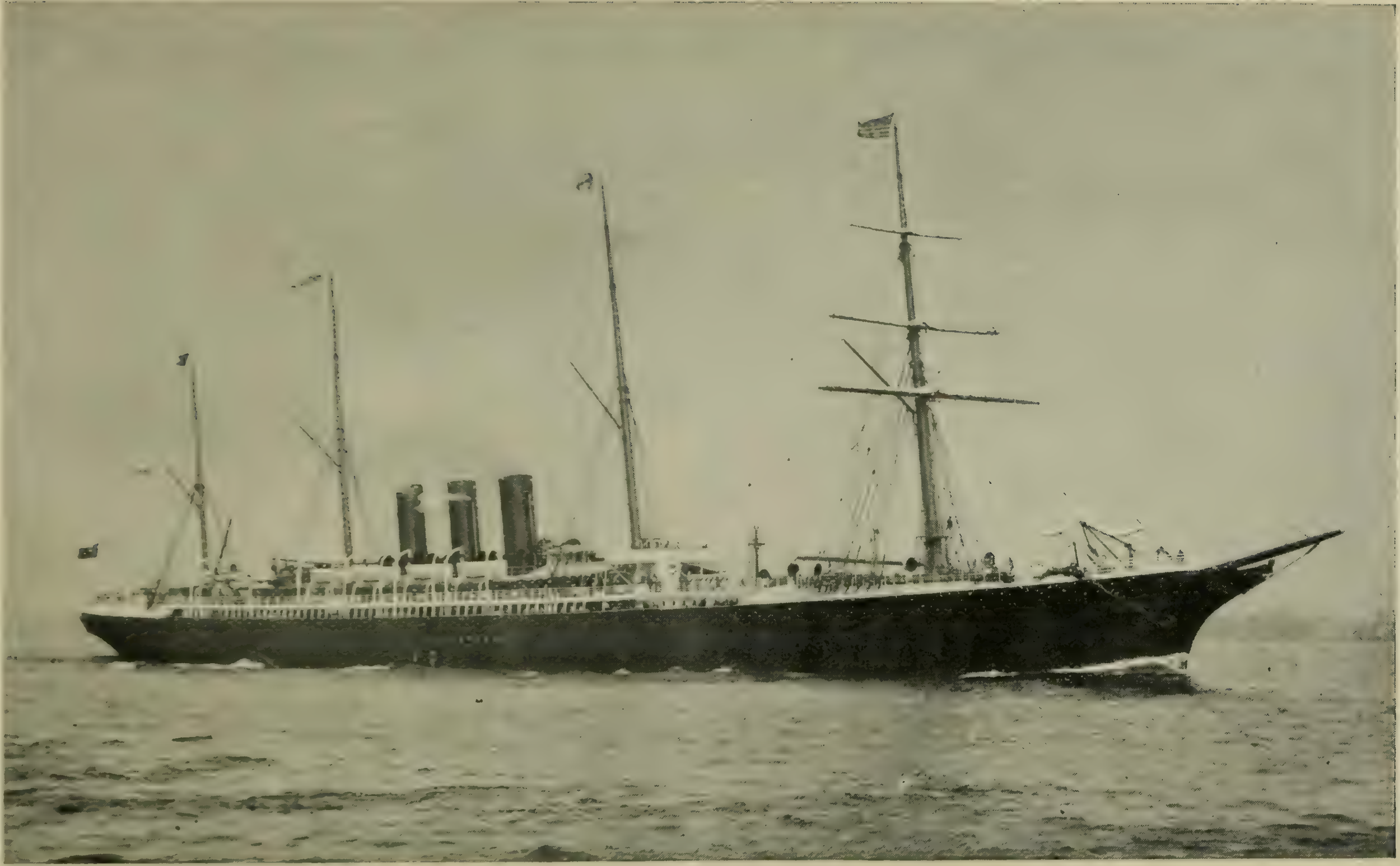
It is my opinion that the past history and associations of many waters are often sufficient to condemn them, no matter how free they may seem to be from organic impurity ; and it is not always necessary to make a laboratory investigation to condemn some of the polluted ones. Then, too, every analyst knows, or should know, the importance of having a thorough knowledge of the surroundings of the source of supply, before giving an opinion of the quality of a water for drinking ; and I believe that no competent chemist will claim that a water high in chlorids and nitrates, although organically quite pure, is good, without a knowledge of the agencies which may pollute it. Inexperienced chemists are in error in sometimes relying wholly, in testing a water, upon the Wanklyn process, which determines the free and albuminoid ammonia, but gives no knowledge of its past history, or of the products of oxidation of its organic matter. Any analyst who finds a water contaminated beyond a reasonable limit of safety is justified in condemning it ; but, because he may fail to find any of the immediate products of decomposition of organic matter, he would not, in my judgment, be warranted in pronouncing such water good, unless he knows that such products have never existed in it ; for it frequently happens that a water having direct communication through the soil with cesspools and privies has but little organic matter in it. The same is true when lime is used to disinfect a privy-vault. In all such cases the amount of chlorids and nitrates in the water is excessively high, and generally the total solids and loss on ignition are also large. Still, this is not different from what we often find in good mineral waters; and a chemist who relies solely on his laboratory determinations might claim that such water is good and safely potable, while in fact it may be a most dangerous beverage and badly infested with disease germs. Thus it is that an opinion of the quality of a water should be given only after a careful consideration of the surroundings of the source of supply. More than this, I believe that no chemist should, and no experienced reputable chemist would, venture a *decisive* opinion as to the purity and wholesomeness of a water supply for a city or town without a *personal* inspection of the topography of the surrounding territory. It is unwise, if not impossible, to predicate an opinion upon the investigation and report of inexperienced men, or to determine the present and prospective soil pollution without a personal inspection of the entire drainage area.

England formerly led the world in the investigation of public water supplies, but in recent years Massachusetts has given us classic results in this as well as in the filtration of water; so in this country we are just beginning to realize that pure water, which was once the luxury of the few, is now the necessity and pleasure of the many. The benefits which have resulted from these and other investigations are attested by the healthful development and increased civilization of our race; for it is now admitted by all competent judges that the progress made by the inhabitants of manufacturing towns, in decency, cleanliness, self-respect, and morality, since the introduction of a pure public water supply, is as striking as the improvement in their health, which shows that pure water is a great moral as well as hygienic agent.

THE GREAT MODERN TRANSATLANTIC STEAMSHIPS.

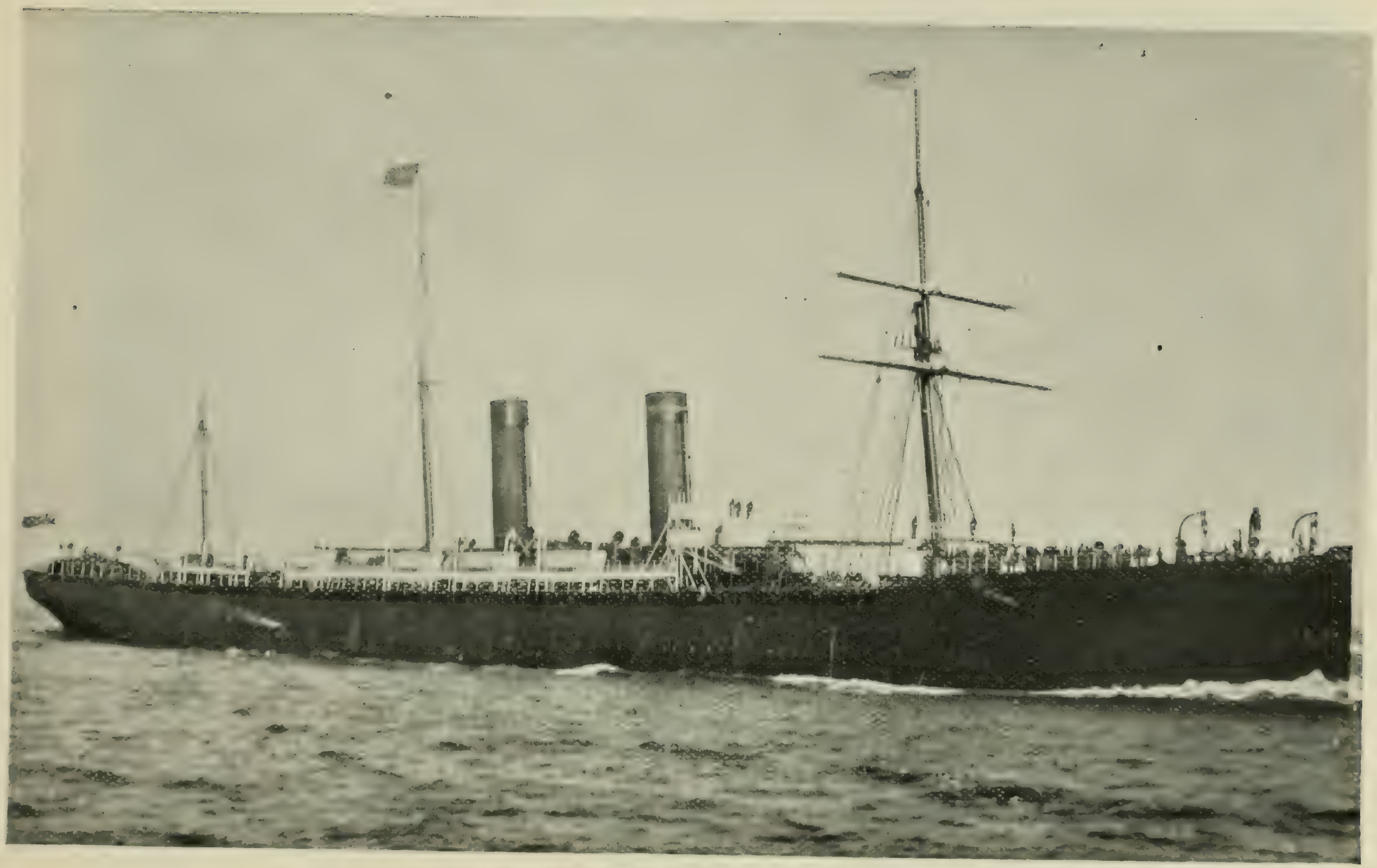
By Samuel Ward Stanton.

IN 1881 three notable steamships made their appearance almost simultaneously in the transatlantic trade between England and the United States. These vessels were the Servia, of the Cunard Line, built by Messrs. J. & G. Thomson, at Clydebank; the Alaska, of the Guion Line, constructed by the Fairfield Shipbuilding Company; and the City of Rome, of the Inman Line, from the Barrow Shipbuilding Company's yard. The Servia, a splendid vessel, was the first of the Cunard Line steamers to be built of steel, and the first great express transatlantic steamer constructed of this metal. The steel used was that manufactured by the Siemens-Martin process. The great power of the engines necessitated a very rigid hull and framework as compared with the older and less powered steamships. The weight of the Servia was 620 tons less than it would have been had iron been used in her construction. She was able to carry more in proportion to her size than could an iron boat of the same dimensions. In connection with this introduction of steel into the construction of transatlantic liners, it is interesting to know that the first steel-plated steamers were the stern-wheel boats Pelican and Banshee, built by Messrs. Henry Bessemer & Co., at Sheffield, England, in 1863, the steel used being made by the bessemer process; thirty-two other steamers were constructed of this material by the same firm up to 1880. These vessels were paddle and screw steamers of the smaller class, none of which ran across the Atlantic. The advantages of steel in strength and lightness as compared with iron remained unappreciated for many years. It is said that in the Great Eastern the ratio of indicated horse power to the tonnage of the vessel was 1 to 14. In the Servia the horse power was greater than the tonnage. This ratio is on the increase, for, with the advent of the latest Cunarders, the Lucania and Campania, we find the tonnage 13,050 and the horse power 31,050. The Servia proved a swift craft, but did not equal the performances of the Alaska, which, soon after her appearance, earned for herself the title "Greyhound of the Atlantic." This latter vessel was not as large as the rival ships, but she carried higher steam pressure, which drove the most powerful engines in proportion to tonnage that any steamship had yet possessed. The indicated horse power to tons gross was 1.514 to 1. The Servia's was 1.393 to 1



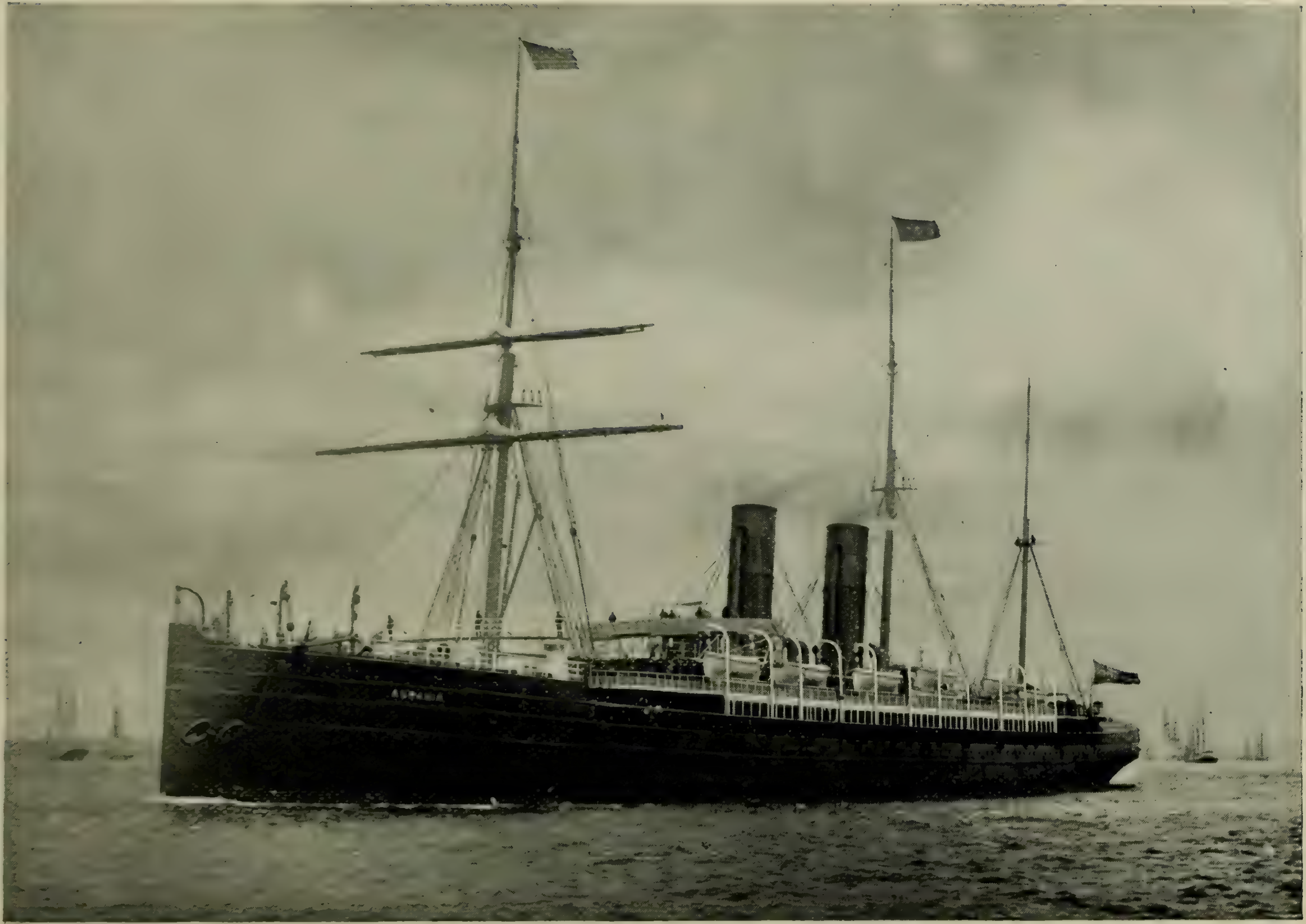
TRANSATLANTIC STEAMSHIP CITY OF ROME, OF THE ANCHOR LINE.

This steamer was the largest that had been constructed since the time of the Great Eastern up to 1881. Length 542½ feet; tonnage 8141.



STEAMSHIP SERVIA, CUNARD LINE, 1881.

First great transatlantic steamship built of steel. Length 515 feet; tonnage 7392; speed, 17 knots.



CUNARD LINE STEAMSHIP AURANIA, 1882.

Length 470 feet; tonnage 7269

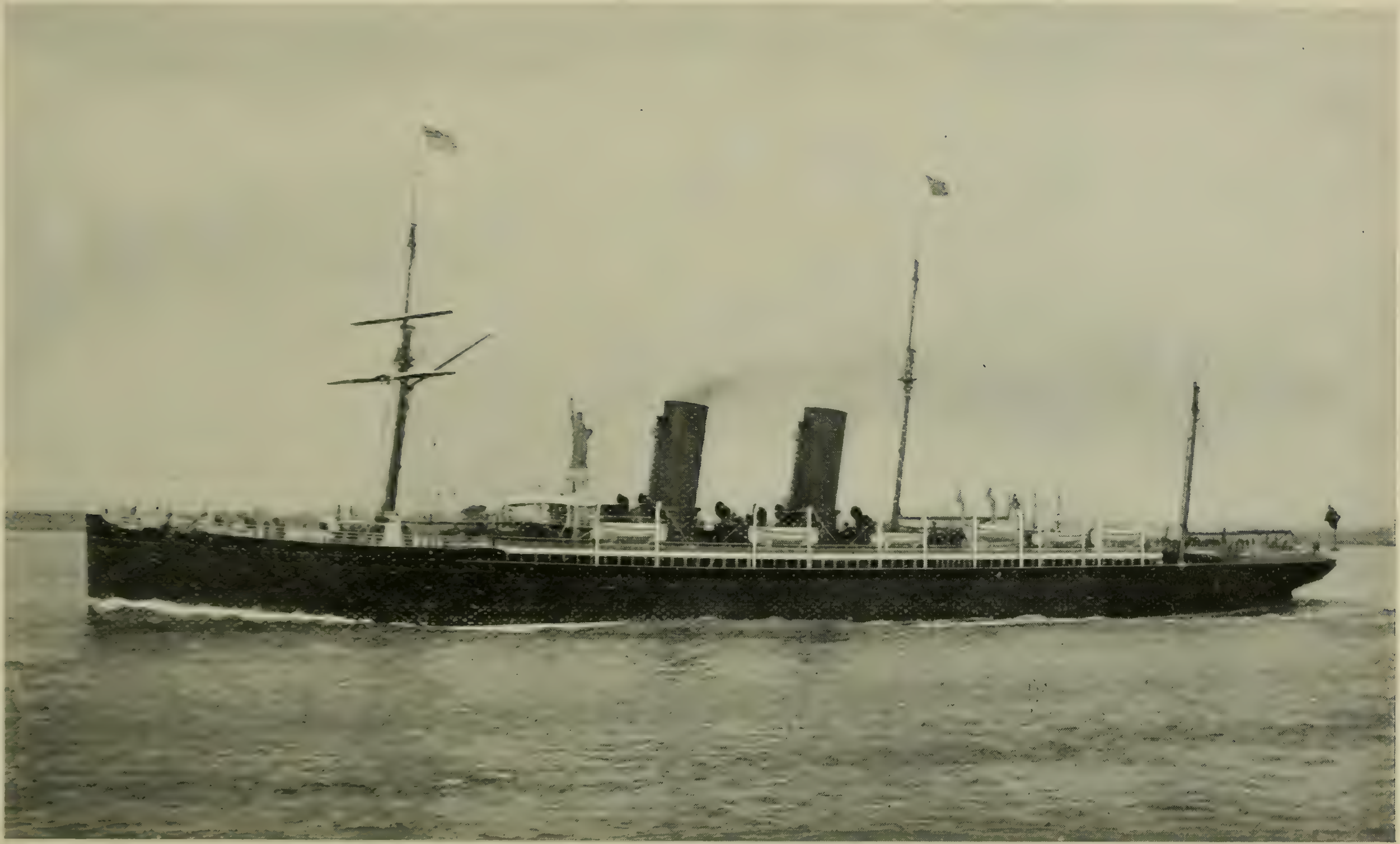
RED STAR [AMERICAN] LINE STEAMSHIP WESTERNLAND, 1883.

Length 455 feet ; tonnage 5736. One of a fleet running to Antwerp.

gross ton, while that of the giant City of Rome was 1.461 to 1. This latter vessel was of 8141 tons,—the largest that had been constructed since the time of the Great Eastern. She was built for the Inman Line, but, not coming up to their expectations regarding speed,—although she was a very fast vessel,—she went back into her builder's hands, who soon succeeded in disposing of her to the Anchor Line, which continues to run her, she being now its chief vessel. The Guion Line steamship Arizona had held the broom for fast passages, but her laurels were soon wrested from her by the new Alaska. This latter vessel made an average speed of 17¼ knots, while her best

STEAMSHIP AMERICA, OF THE NATIONAL LINE, 1884.

Length 432 feet ; tonnage 6500. Speed 17.8 knots an hour.



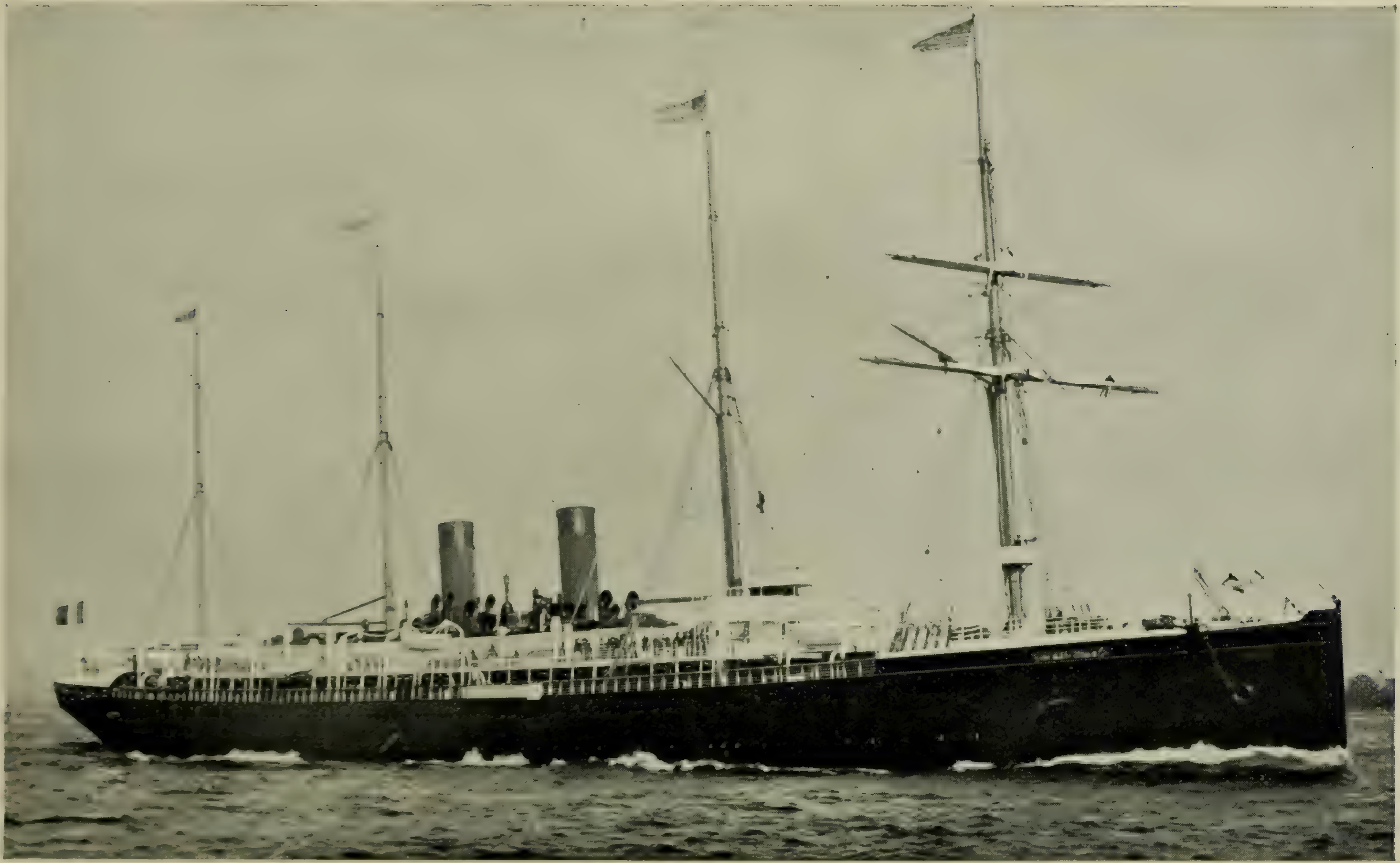
CUNARD LINE STEAMSHIP UMBRIA, BUILT 1884.

With her mate, the Etruria, held the record for fastest transatlantic passages for five years. Length 500 feet; tonnage 7718; 20.18 knots an hour.

day's run was 430 knots,—in October, 1883, going eastward. The Servia very nearly equalled this performance, having logged off 427 knots in one day during the same month. In May, 1888, the Etruria made 503 knots in one day, and since that the Paris has made 515 knots. The record at present is 560 knots, made by the Lucania.

Following the City of Rome, Alaska, and Servia, the next important liners that were put afloat were the Aurania, for the Cunard Line, the Oregon, for the Guion Line, and the America, for the National Line. This latter vessel was the smallest of the trio, but was possessed of a splendid model, her proportion of length to beam being 8.47 to 1, and her indicated horse power 1.131 to 1 gross ton. In the Aurania the proportion of length to beam was 8.24 to 1, while the indicated horse power was 1.169 per ton, as against the Oregon's 1.678 indicated horse power; the proportion of length to beam in the Oregon was 9.25 to 1. The indicated horse power of these steamers was as follows: Oregon, 12,382; Aurania, 8,500; America, 7,354. The Oregon made nearly 20 knots on her trial trip, and, soon after beginning her transatlantic voyages, made a day record of 440 knots; later this performance was eclipsed by the America, which made a record of 477 knots. While the Oregon held the record for the fastest passages, the America closely pressed her. The Oregon passed into the hands of the Cunard Line, by purchase, and was subsequently lost, while the America was bought by the Italian government for use as a cruiser. The building and running of the America was the only instance in the history of the National Line when that company had built a modern fast passenger steamer to compete with the better class of steamships in the trade in question; her consorts in the same line were not speedy or comfortable enough, however, as compared with the America and other modern boats, to enable the line to sustain the reputation which she brought to it, and so the company abandoned the plan of attempting to secure a share of the first-class travel.

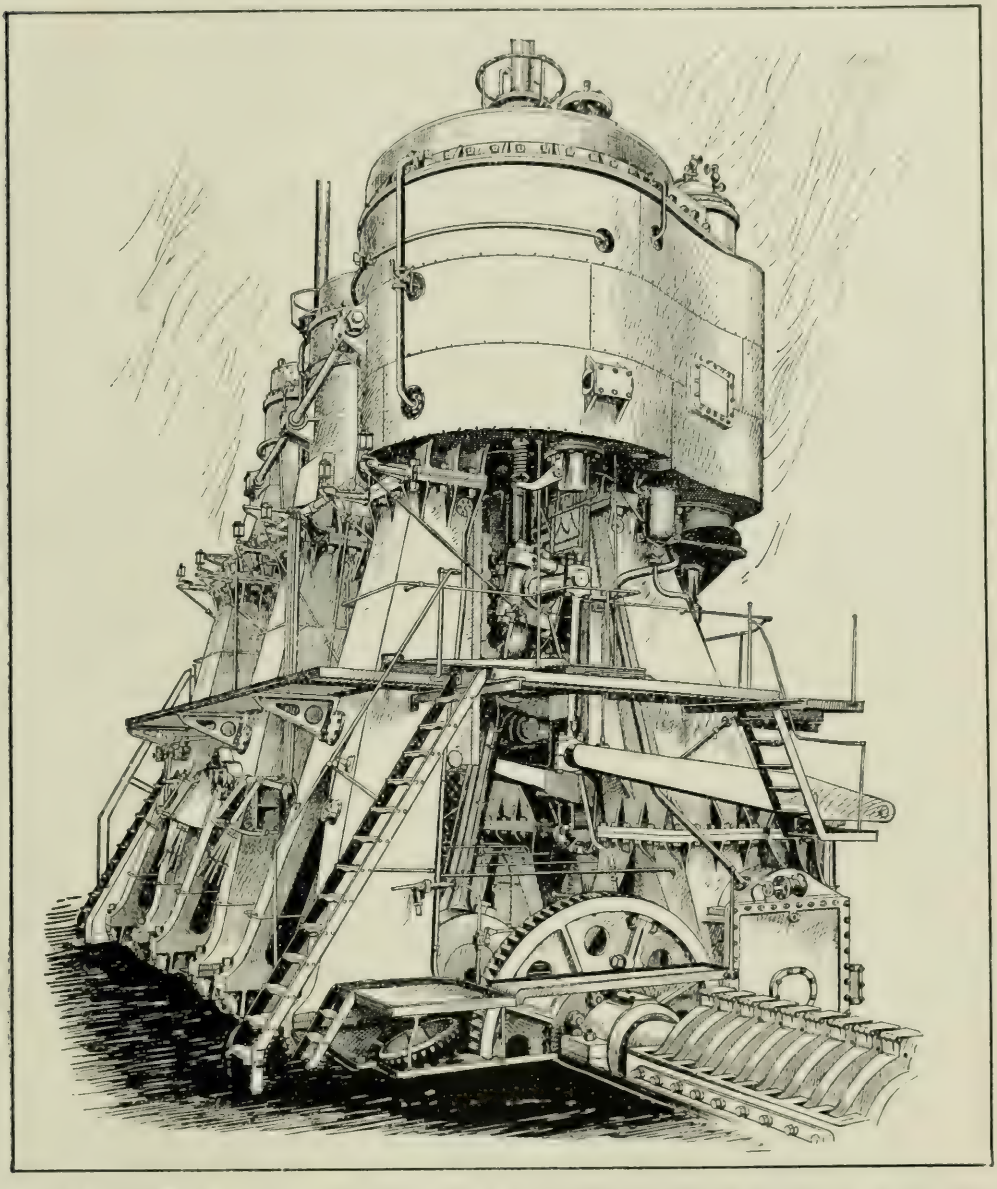
The Cunard Line regained its supremacy in the performances of the single screw steamers Umbria and Etruria, with compound engines, which, for 5 years, eclipsed the records of all other ocean steamships. During the first five years of their life their time of crossing the Atlantic was a little over 6 days. In the Umbria the proportion of length to breadth was 9.25 to 1, and in the Etruria it was 8.76 to 1, while the indicated horse power of each was about 14,321, or in the proportion of 1. 85 to 1 gross ton. Their performances were very nearly the same. In 1888 the 503 knots covered in one day by the Etruria, while on her passage from England,—about 20.3 knots an hour,—was the fastest that had ever been attained at sea.



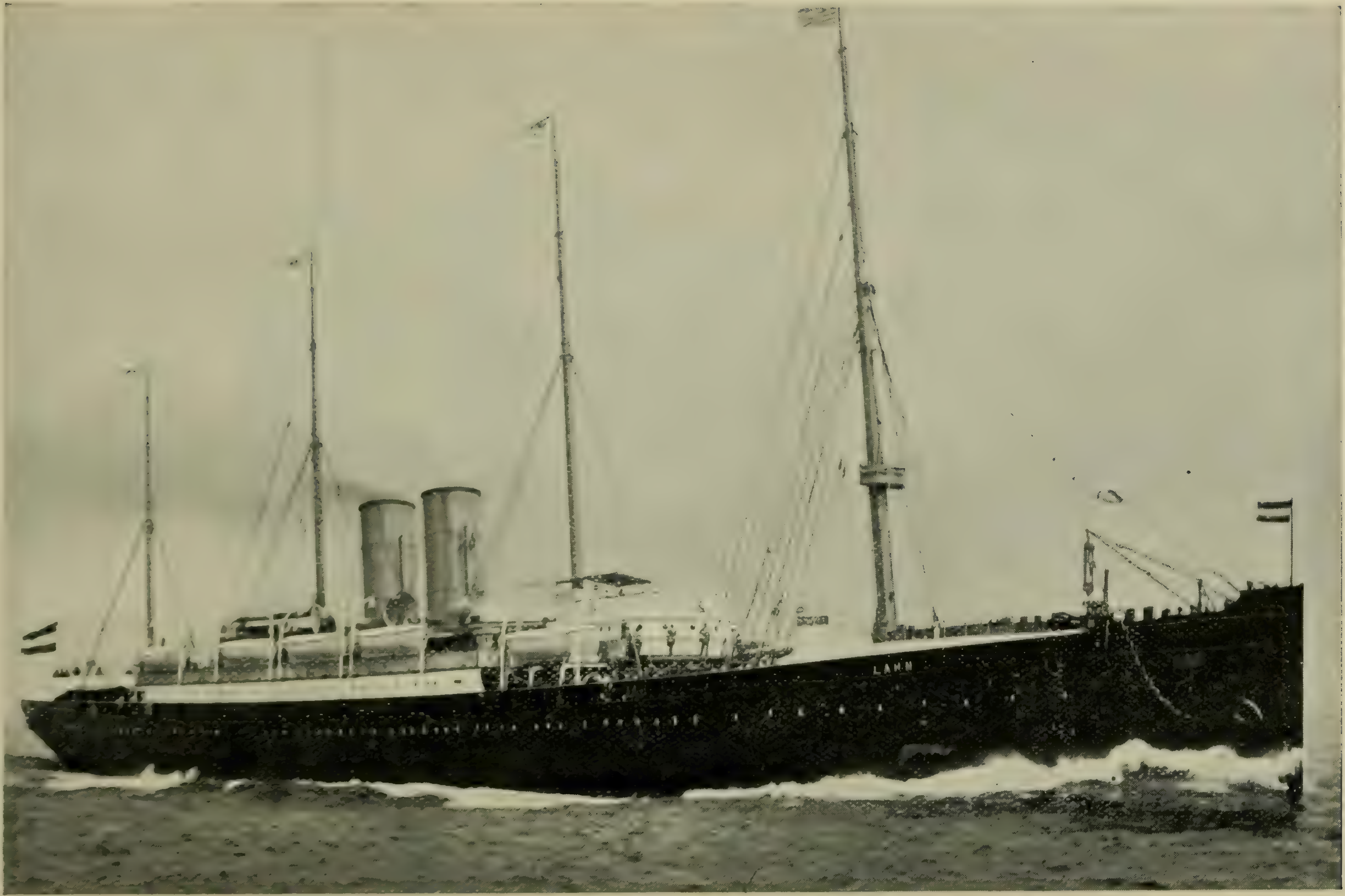
FRENCH LINE STEAMSHIP LA BRETAGNE, 1886.

Length 493 feet; tonnage 7112; speed 17½ knots an hour.

Four important steamers appeared in 1889-90, immediately taking the leading place in the transatlantic trade. These were the City of New York and City of Paris (now New York and Paris), of the Inman Line, and the Majestic and Teutonic, of the White Star Line,— all four vessels, in their trips across the ocean, bringing the record under 6 days. The City of Paris made 515 knots in one day in 1889, which was considered phenomenal. In the Paris we find that the proportion of length to beam is 8.37 to 1, while in the Teutonic it is 9.82 to 1.



ENGINE OF THE ALLER. FIRST TRIPLE-EXPANSION ENGINE USED ON A TRANSATLANTIC LINER, 1885.



THE LAHN, OF THE NORTH GERMAN LLOYD STEAMSHIP CO.

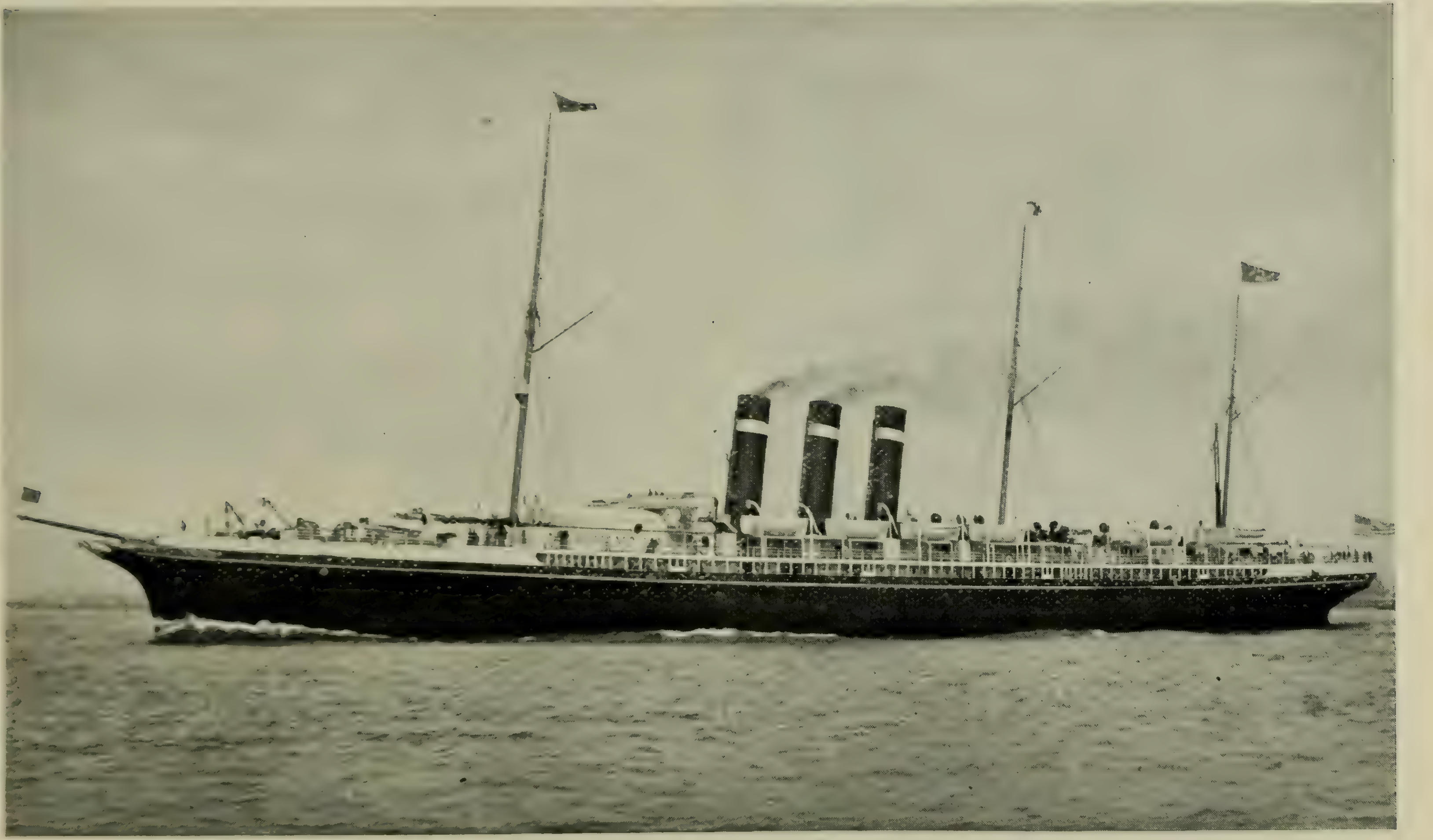
Length 448 feet; tonnage 5661. The lost Elbe was similar to this vessel.

The keel of the Teutonic was laid in March, 1887, but it was not until August 7, 1889, that she left Liverpool on her first trip to New York. On this passage she crossed from Queenstown to New York in 6 days, 14 hours, and 20 minutes,—at that time the quickest maiden voyage that any steamship had ever attained. The Majestic made her first trip across the Atlantic in April, 1890, reaching New York in 6 days, 10 hours, and 30 minutes. These two vessels have almost always maintained a speed of 19 to 20 knots in their passages across the Atlantic. It is claimed that either of them, should necessity arise, would be capable of steaming from Portsmouth to Bombay, *via* the Cape of Good Hope,—a distance of 10,730 nautical miles,—in 22 days, without coaling on the way.

STEAMSHIP LA BOURGOGNE, OF THE FRENCH LINE, 1886.

Length 49¼ feet; tonnage 7395; speed 17½ knots.

To the North German Lloyd Steamship Company belongs the honor of using the first triple expansion engine in the transatlantic service. The vessel in which it was placed was the Aller, constructed by the Fairfield Shipbuilding Company in 1885. Two other vessels, similar in all particulars to the Aller,—the Trave and Saale,—followed, and were succeeded by the Lahn, the latter with a 5-cylinder triple-expansion engine. Contracts were then given to the Vulcan Works, at Stettin, resulting in the Spree and Havel, in which vessels we find evidence that the German shipbuilders are as thoroughly up-to-date as their English contemporaries. The Hamburg-American Line added



AMERICAN LINE STEAMSHIP PARIS.

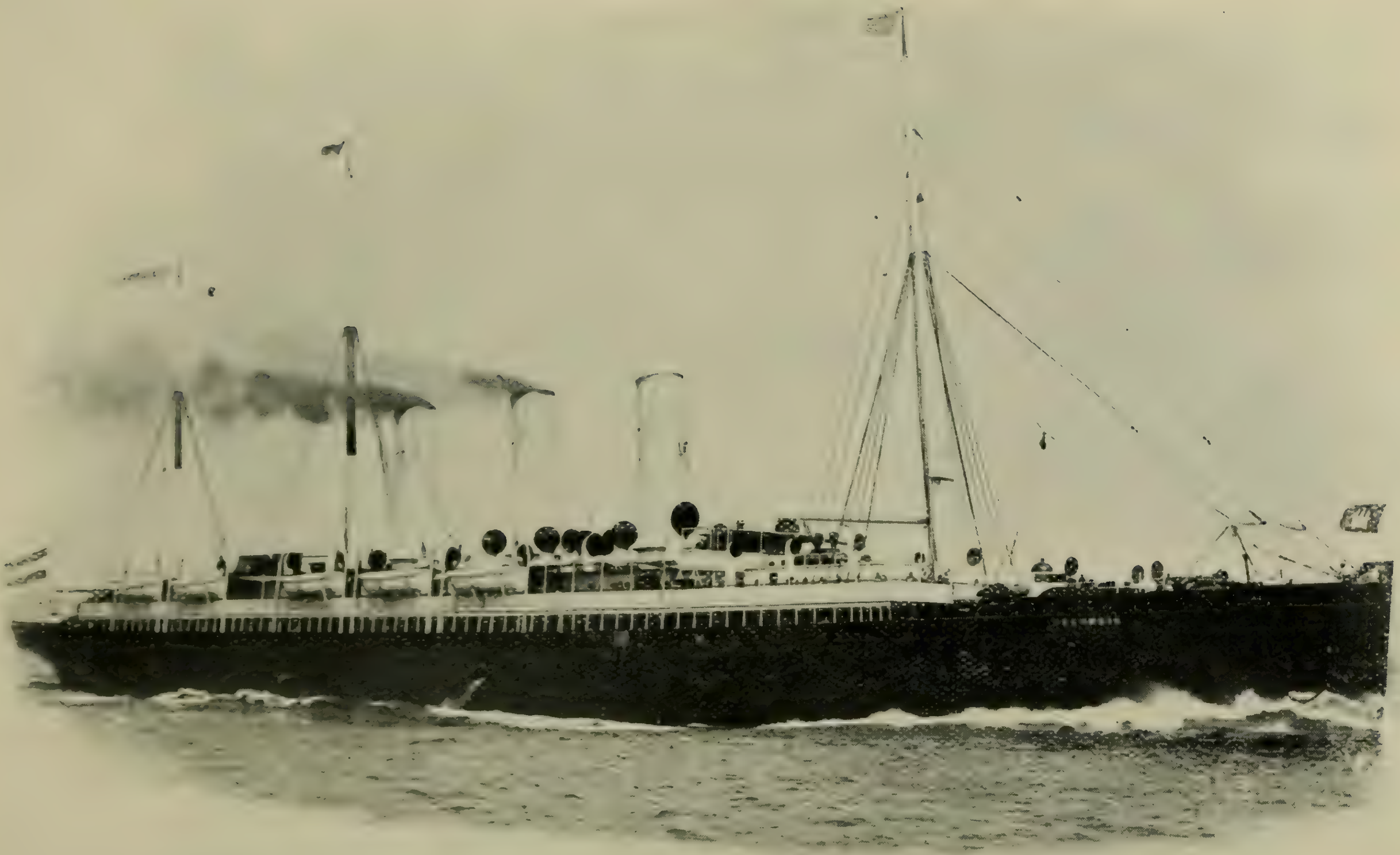
Length 527 feet; tonnage 10,499. One of the swiftest ocean vessels afloat. The New York is a companion ship.

to its fleet the fine steamers Columbia and Normannia, built in England, in 1889 and 1890, and the Augusta Victoria and Fürst Bismarck, built by the Vulcan Co., in 1889 and 1891, the two latter being magnificent triple-expansion engined ships. The Bismarck is able to steam nearly 21 knots an hour. The French have not been behindhand in the building of modern, high-class transatlantic steamers, as the Compagnie Generale Transatlantique's fine vessels testify, their latest steamer, La Touraine, with twin screws, being able to steam 19 knots an hour. Like the best of the steamships of her rival nations, the newer steamers of the French Line are held as naval reserve vssels by the government of that country.

The performances of the steamers of the rival lines being so much better than those of its own fleet, the Cunard Company contracted, in 1891, with the Fairfield Shipbuilding Company for two of the highest-powered transatlantic steamships that had ever been constructed, as well as the largest since the time of the Great Eastern. These two vessels were the Campania and Lucania, the greatest merchant

STEAMSHIP AUGUSTA-VICTORIA, OF THE HAMBURG-AMERICAN LINE.

Length 460 feet; tonnage 7661. Built in Germany.



HAMBURG-AMERICAN LINE STEAMSHIP COLUMBIA.

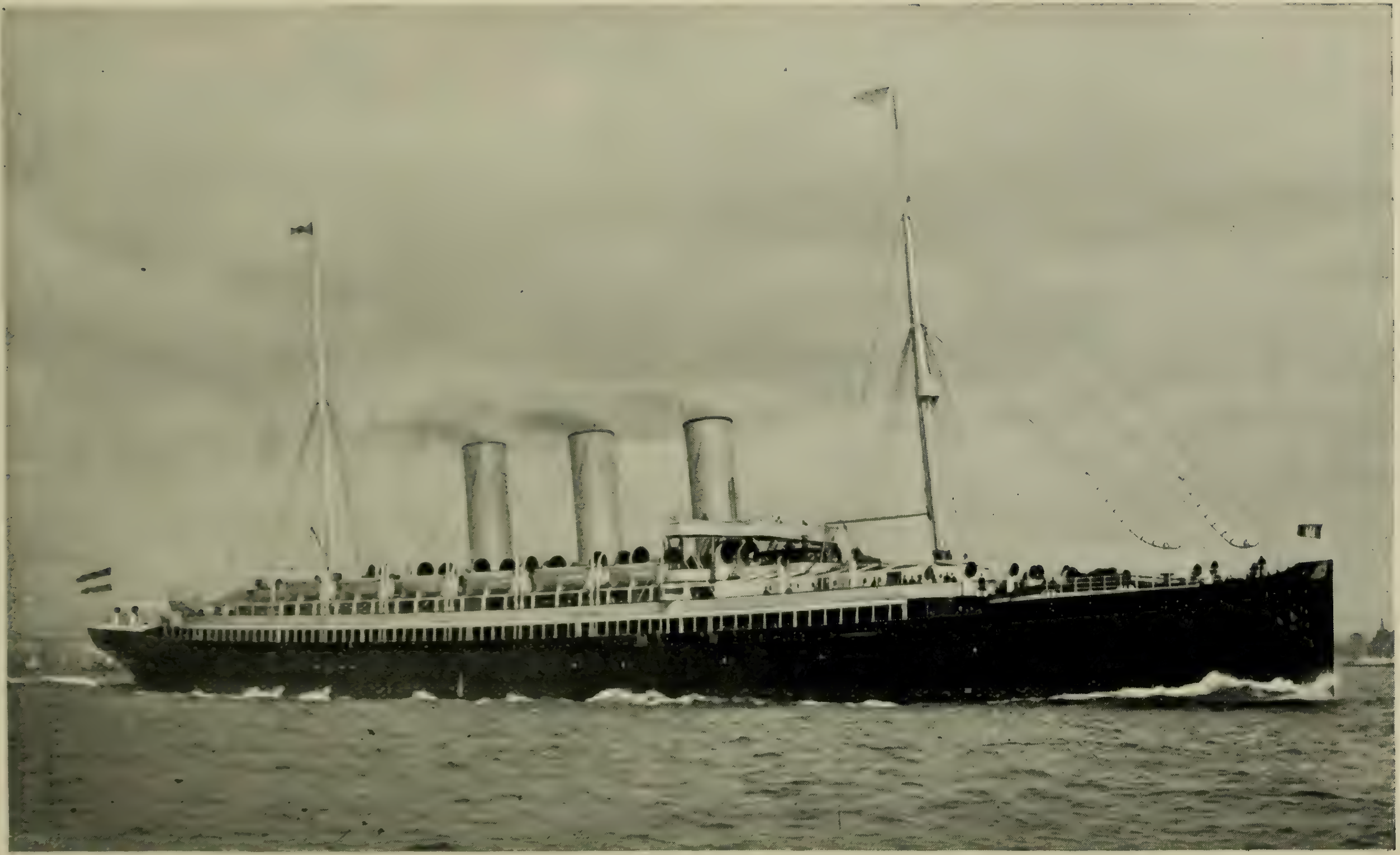
Length 462½ feet ; tonnage 7578. Speed, over 19 knots an hour.

steamers afloat to-day, each of which, when ready to leave on her first voyage, represented an expenditure of nearly $4,000,000. With a tonnage of 13,050 and an indicated horse power of 31,050, these wonderful specimens of naval architecture embody the experience of nearly a century, and bear striking witness to man's ingenuity. They are constructed on the cellular principle, which admits of the use of water for ballast, and are the highest-grade steamers that England has ever produced. At the end of her first year's service the Campania had covered, in nine voyages, over 50,000 nautical miles, at an average of 20.304 knots, and the Lucania, in six voyages aggregating 33,500 miles, averaged 20.394 knots. This gave these giant steamers an advantage of 1¼ nautical miles per hour over the next best vessels in the Atlantic service,—*viz.*, the Majestic, Teutonic, New York, and Paris.

FASTEST PASSAGES OF TRANSATLANTIC STEAMERS BETWEEN NEW YORK AND QUEENSTOWN, 1882–1895.

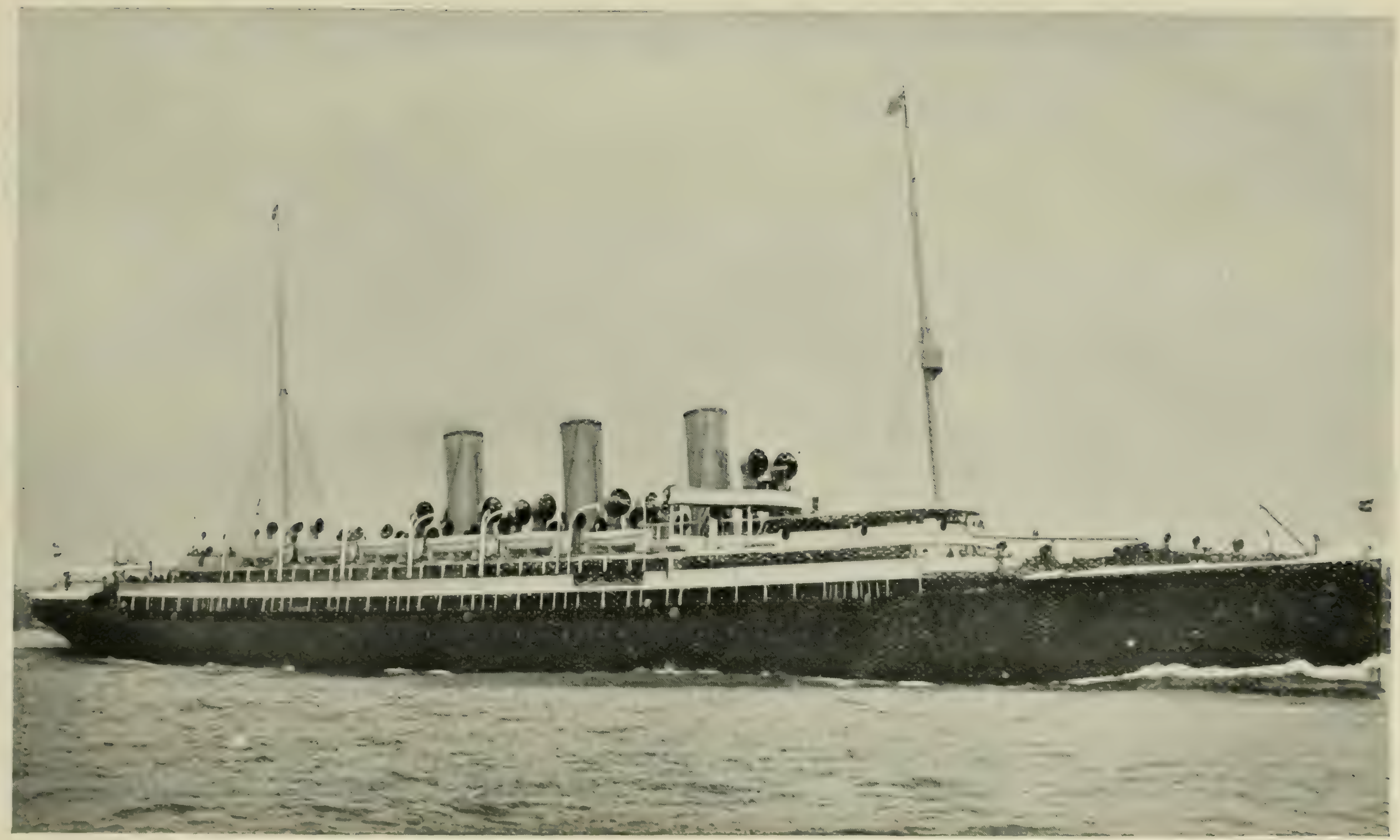
1882	Alaska, Guion Line, westward	7 days	6 hours	43 min.
1882	“ “ eastward	6 “	22 “	0 “
1884	Oregon, “ westward	6 “	9 “	42 “
1884	America, National Line, eastward	6 “	14 “	8 “
1884	Oregon, Guion Line, eastward	6 “	11 “	9 “
1885	Etruria, Cunard Line, westward	6 “	5 “	31 “
1887	Umbria, “ “	6 “	4 “	42 “
1887	Etruria, “ eastward	6 “	4 “	36 “
1888	“ “ westward	6 “	1 “	55 “
1889	City of Paris, Inman Line, westward	5 “	19 “	18 “
1889	“ “ eastward	5 “	22 “	50 “
1891	Teutonic, White Star Line, westward	5 “	16 “	31 “
1891	“ “ “ eastward	5 “	21 “	3 “
1892	City of Paris, Inman Line, westward	5 “	14 “	24 “
1893	Campania, Cunard Line, eastward	5 “	12 “	7 “
1894	“ “ westward	5 “	9 “	6 “
1894	Lucania, “ eastward	5 “	8 “	38 “
1895	“ “ westward	5 “	7 “	23 “

It is not out of place to say that the American Line has really been the foremost transatlantic steamship line in the successful application of improvements to its steamers, and the history of the line forms a striking lesson in steamship progress. Originally starting as the Inman Line, in 1850, as we know, with screw steamers, when all other lines were building paddle vessels, these pioneer steamships were provided with special quarters for steerage passengers. Iron, too, was one of the improvements in the construction of hulls which this line introduced. Then came the early adoption of the compound engine, when its merits were as yet almost unknown, followed by the triple expansion of steam, as soon as its practicability was demonstrated. This line, too, introduced the incandescent light and the search light; and it adopted the twin screw for the propulsion of its steamers. Finally,



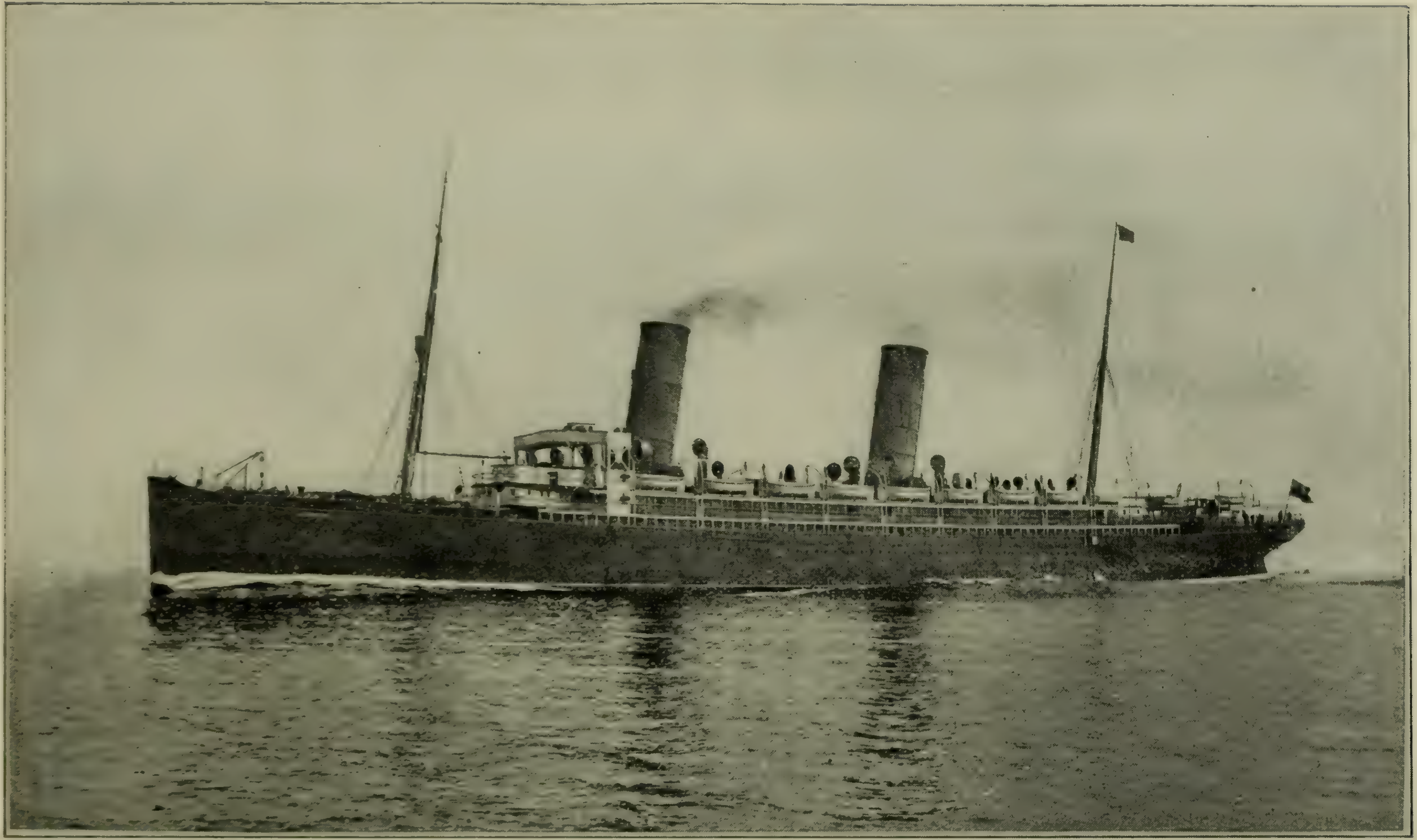
STEAMSHIP NORMANNIA, OF THE HAMBURG-AMERICAN LINE.

Length 500 feet ; tonnage 8716 ; speed 20.78 knots an hour,



THE HAMBURG-AMERICAN LINE STEAMSHIP FURST BISMARCK.

Length 502½ feet; tonnage 8250; speed, over 20 knots an hour.



TRANSATLANTIC STEAMSHIP LUCANIA, OF THE CUNARD STEAMSHIP CO.'S ROYAL MAIL LINE.

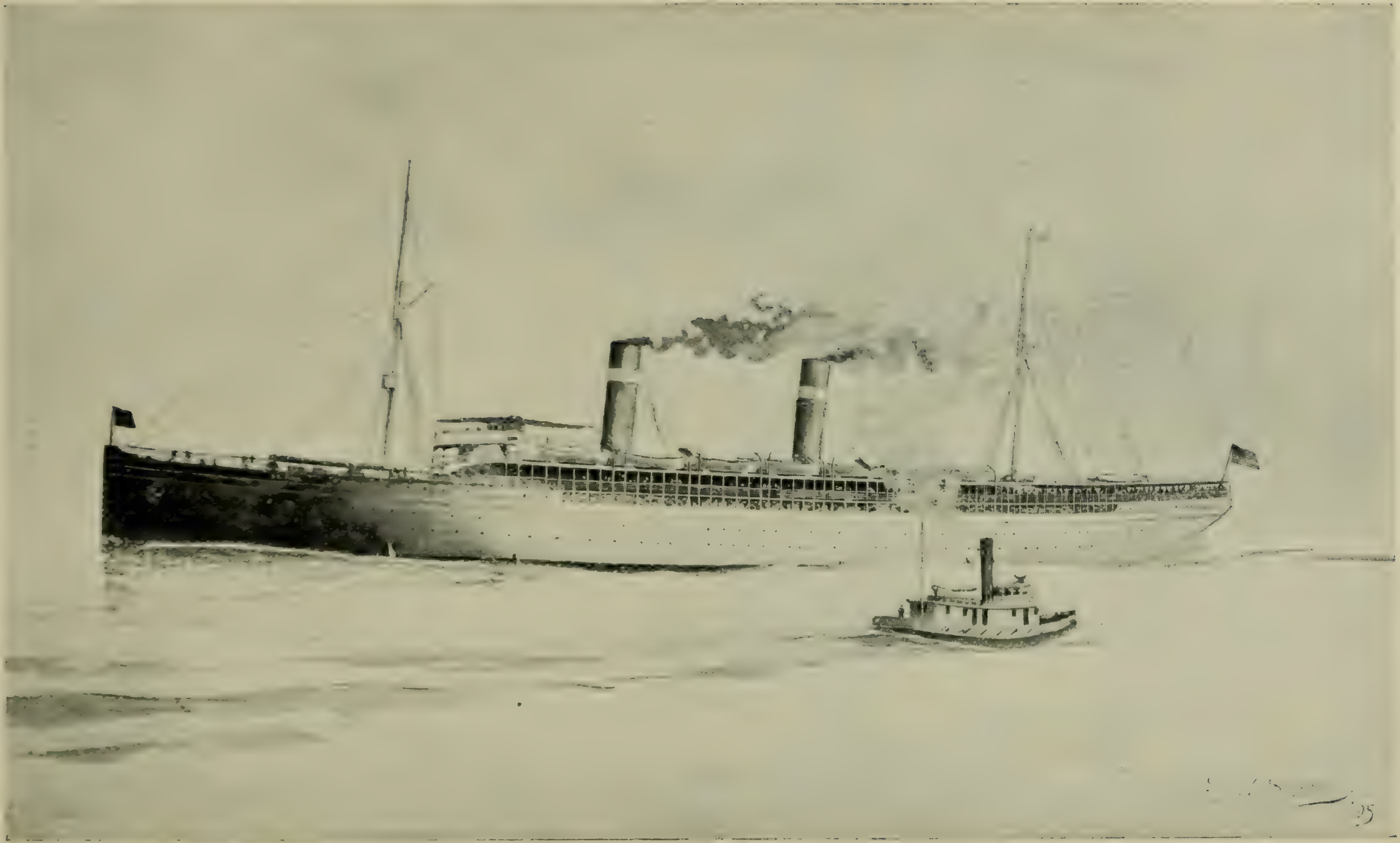
This vessel and her mate, the Campania, are the largest ocean steamers ever constructed [the Great Eastern excepted], being the fastest and highest powered of any afloat. Length 600 feet ; tonnage 12.050. The Lucania made, on her trial trip, 23.18 knots [nearly 27 miles] in one hour.

we find that the company's newest vessels, the St. Louis and St. Paul, are equipped with quadruple-expansion engines, the largest ever built and the first to be used in transatlantic steamers. These two vessels constitute the most important advance in naval architecture ever made in the history of shipbuilding in the United States. They have been in service some time, and have proven themselves in every way fully up to the highest requirements of the service; and, while they have not attained the speed of the giant Cunarders (they have but 2/3 the power of these ships), they have numerous improvements over all others, and in some respects are in advance of the Lucania and Campania. The St. Louis and St. Paul were built by the Wm. Cramp & Sons' Ship and Engine Building Co., and are the largest steamers ever built in America. In designing them special attention was given to the question of safety, and their hulls are so subdivided by transverse bulkheads that, should two of them become damaged and the water enter and fill them, the ship would still float on in perfect safety. To support the outboard shaft bearings the hulls were built out in a horizontal web to a steel frame, having both bosses cast in one piece, and weighing about 28,000 lbs.

TWIN SCREW STEAMSHIP MAJESTIC OF THE WHITE STAR LINE.

Length 566 feet; tonnage 9861. Has a mate in the Teutonic, both having a speed of 21 knots an hour.

It is interesting to note that, with the completion of the St. Paul,



THE AMERICAN LINE STEAMSHIP ST. PAUL, PLYING BETWEEN NEW YORK AND SOUTHAMPTON, ENGLAND.

With her mate, the St. Louis, these vessels are in some respects the peers of any afloat, while their speed is only surpassed by their higher powered rivals of the Cunard Line. Each vessel is 534 feet in length, with a tonnage of 11,629. The indicated horse power is 20,000, giving a speed of 22.5 knots [nearly 25 miles an hour].

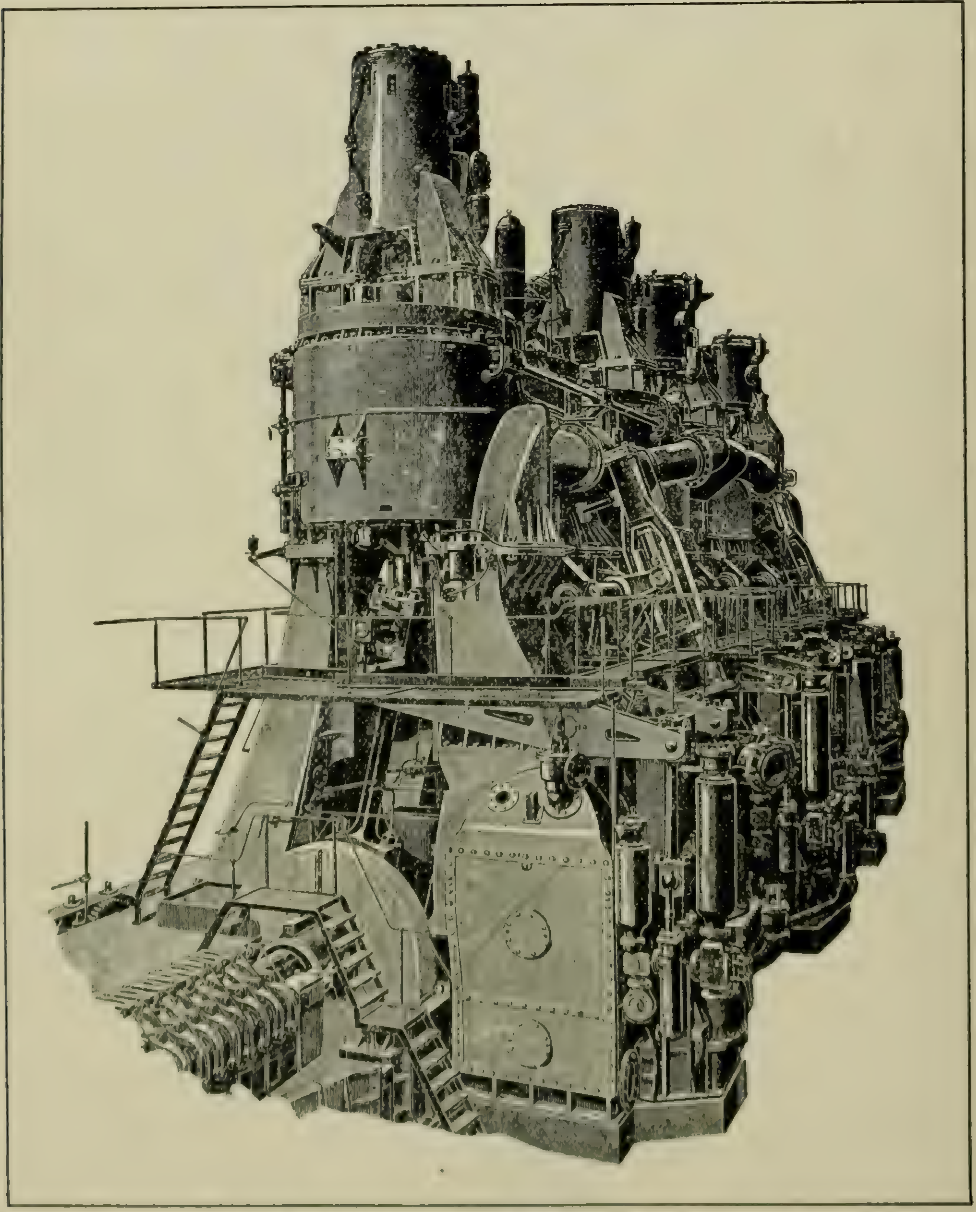
the United States government has at its disposal four magnificent steamships, which, in case of war, can be used as merchant cruisers. These are the New York, Paris, St. Louis, and St. Paul. They have been specially arranged so as to be readily and quickly convertible into armed cruisers, carrying 6-in. rapid fire guns, and with their great speed they would prove exceptionally fine naval vessels. For this privilege, we grant a weekly mail service, for which we pay $756,724 annually. A year ago the Cunard and White Star Lines received from the British post-office department the sum of $527,500 for a semi-weekly mail service to this country, added to which the British admiralty gave $113,295, making a total of $640,795. In the same period the United States government paid to the Cunard Line $129,000, and to the White Star Line $47,176,—making the total paid by both countries $817,871. At the same time the United States paid to the American Line $188,720, to the North German Lloyd Line $157,764, and to the Hamburg American Line $45,311.

Five splendid twin-screw steamships have recently been built for the Hamburg-American Line,—*viz.*, the Palatia, Patria, Persia, Prussia, and Phœnicia. The Persia and Prussia were the only vessels built outside of Germany, these two boats coming from the shipyard of Harland & Wolff, at Belfast, Ireland. The Hamburg-American Line has lately contracted with the shipbuilding firm of Harland & Wolff for the largest steamship since the Great Eastern, eclipsing in size even the Lucania and Campania, though not intended to steam more than 15 miles an hour. The principal dimensions are to be 560 ft. in length, 62-ft. beam, and 42 ft. in depth of hold, with a carrying capacity of 13,000 tons and a displacement of about 20,000 tons. While she is intended especially to carry a great cargo, she will have accommodations for 200 cabin and 1500 steerage passengers. There will be twin screws, driven by triple-expansion engines, and but one funnel.

COMPARISON BETWEEN THE BRITANNIA (1840) AND CAMPANIA (1895).

Britannia		Campania	
Length	207 ft.	Length	600 ft.
Breadth	34 ft. 3 in.	Breadth	65 ft.
Depth	22 ft. 5 in.	Depth	43 ft.
Tonnage	1,135	Tonnage	12,050
Indicated h. p.	740	Indicated h. p.	31,050
Cargo capacity	225	Cargo capacity	1,620
Speed per hour	8.5 knots	Speed per hour	23.18 knots
Crew	50	Crew	425
Fuel consumption per 24 hours	38 tons	Fuel consumption per 24 hours	450 tons
Hull of	Wood	Hull of	Steel
Style of engine	Paddle	Style of engine	Twin-screws
Cost about	$100,000	Cost about	$3,550,000
Time of passage	15 days	Time of passage	5 days, 8 hours

When the City of Berlin came out in 1875, she was one of the fleetest of the transatlantic steamers, vieing with the Germanic and Britannic in the honor of holding the record. During late years this vessel has been running with new and improved engines of greater power, but her performance has not been noticeably bettered. The Germanic and Britannic, on the contrary, with new engines, have improved on their former records, and are faster boats now than they ever were. In fact, these two latter vessels are used in the express



TRIPLE-EXPANSION ENGINE OF THE LUCANIA.

One of the 5 cylinder engines of the Lucania and Campania [there are two in each ship], indicating over 15,000 horse power.

service with the Teutonic and Majestic, and perform their trips with as much regularity and nearly as swiftly as their larger consorts. The Germanic, for instance, with her new triple-expansion engines, burns 30 tons of coal less per day, and her speed has increased a couple of knots an hour.

Between no other points on the globe has such an enormous trade sprung up as that existing at the present time between New York and the ports of Great Britain and Continental Europe. During 1894 879 passenger vessels arrived at the port of New York, bringing with them 92,561 cabin and 188,164 steerage passengers. While this showing is very good as to first-class passengers, there is a wide difference between the number of emigrants in 1894 and the 445,290 of 1891. Few people there are, comparatively, who realize the immense receipts and expenditures of a great transatlantic line. A steamship of any of the regular passenger lines to England, France, or Germany must earn from $50,000 to $100,000 per voyage to make a profit. The money that is made on the ocean nowadays comes from well-filled passenger lists, and therefore only lines owning and operating the largest and swiftest vessels can manage to pay dividends to stockholders. One famous line, the Guion, was forced to give up last year, and its steamers, the Arizona and Alaska, the queens of the ocean only 15 years ago, were laid up. Even in the cargo-carrying trade, nothing but the largest steamers, fitted with the most modern machinery and labor-saving appliances, are profitably worked.

It would seem that any company desirous of keeping to the front in the transatlantic passenger trade must still further increase the size and the power of its vessels, and, considering the mammoth proportions, immense power, and great cost of the present boats, which do not run with any great profit, it is a question whether the limit has not been reached. True, the North German Lloyd steamer will be larger than any now afloat, but she is not to be of great speed, nor will she consume in her running expenses the passenger and freight receipts of the voyage. That the ocean steamer of the present day is a safer, more comfortable, and vastly swifter boat than the vessels of a few years ago goes without question. The twin screw has undoubtedly worked wonders in regard, not only to speed, but to safety as well, one of the large liners, the St. Louis, having recently been steered into port by means of her propeller wheels, the rudder having become disabled. In 1890, while on the passage to England, the starboard engine of the City of Paris was completely wrecked by the breaking of the shaft, and the water, coming in, flooded the engine room, and, on account of the breaking at the same time of a portion of the bulkhead, the water also passed into an adjoining compartment. The vessel was

PROMINENT TRANSATLANTIC STEAMSHIPS, 1881-1895.

Year Built.	Name and Line.	Tonnage.	Trial Speed	Builders.	Length.	Breadth.	Depth.	Diameter of Cylinders and Stroke, in Inches.	Indicated horse power.
			knots		ft.	ft.	ft.		
1881	Alaska, Guion Line	6932	18	Fairfield Shipbuilding Co.	500	50	39	One 68, two 100×72	10500
1881	Servia, Cunard Line	7392	17	J. & G. Thomson, Glasgow	515	52	40½	One 72, two 100×78	10300
1881	City of Rome, Anchor Line	8141	18.23	Barrow Shipbuilding Co.	542½	52	39	Three 46, three 86×72	11900
1881	Elbe, North German Lloyd	4510	16.5	John Elder & Co. (Fairfield Co. Succes)	418	44	35		5600
1882	Aurania, Cunard Line	7269	17.5	J. & G. Thomson	470	57	39	One 68, two 91×72	8500
1883	Oregon, Guion Line	7375	18.3	Fairfield Shipbuilding Co.	500	54	40	One 70, two 104×72	13300
1883	Eider, N. German Lloyd	4719	17	" " "	429	47	34	One 62 & 86×60	7000
1883	Westernland, Red Star L.	5736	14	Laird Bros., Birkenhead	455	47	35	One 52 & 93×66	
1884	America, National Line	6500	17.8	J. & G. Thomson	432	51	38	One 63, two 91×66	7354
1884	[1]Umbria, Cunard Line	7718	20.18	Fairfield Co., Glasgow	500	57	40	One 71, two 105×72	14321
1885	Aller, N. German Lloyd	5381	17.5	" " "	438	48	34	One 44, 70 & 108×71	8161
1886	[2]La Champagne French L.	7087	17.5	Compagnie Générale Trasatlantique, St. Nazaire	493	51	33	One 90 & 41×67	9800
1886	[3]La Bourgogne, " "	7395	17.5	Société des Forges et Chantiers de la Méditerranée, La Seyne	494	52	34	One 90 & 41×67	9800
1887	Lahn, N. German Lloyd	5661	17.78	Fairfield Co.	448	48	36½	Two 32½, one 65, two 85×72	8900
1888	[4]Paris,* Inman (Am.) L.	10499	21.08	J. & G. Thomson	527½	63	41	Two 45, 71 & 113×60	20600
1889	Augusta-Victoria,* Hamburg-American Line	7661	18.31	Vulcan Shipbuilding Co., Stettin	460	55½	39	" 41, 66 & 106×63	14110
1889	Columbia,* Hamb. Am. L.	7578	19.15	Laird Brothers	462½	55	39	" 41, 66 & 101×66	13680
1890	[5]Teutonic,* White Star L.	9686	21	Harland & Wolff, Belfast	565	57½	42	" 43, 68 & 110×60	19500
1890	Normannia,* Hamb.-Am.	8716	20.78	Fairfield Co.	500	57	38	" 40, 67 & 106×66	16352
1890	[6]Spree,* N. German Lloyd	6963	19.6	Vulcan Co.	463	51	37½	" 38, 75 & 100×72	13000
1891	Furst Bismarck,* H.-Am.	8250	20.7	" "	502½	57	38	" 43, 67 & 106¼×63	16412
1891	La Touraine,* French L.	9209	19	Built at St. Nazaire	520	56	34	" 44, 60 & 100×65	13600
1893	[7]Campania,* Cunard Line.	12050	23.18	Fairfield Co.	600	65	43	Four 37, two 79, four 98×69	31050
1895	[8]St. Louis,* American L.	11629	22.5	Wm. Cramp & Sons, Ship and Engine Building Co.	534	63	42	Four 28½, two 55, six 77×60	20000

*Twin Screws. [1]Mate to Etruria, [2]Mate to La Bretagne, [3]Mate to La Gascogne, [4]Mate to New York, [5]Mate to Majestic, [6]Mate to Havel, [7]Mate to Lucania, [8]Mate to St. Paul.

near Queenstown at the time, and was towed into port, where the leak was stopped, and she proceeded to Liverpool under her own steam only a short time after. Such an accident happening to any of the old class of single screw boats would have undoubtedly proved fatal. It is only a question of time, it is said, when triple-screw express steamers will be put afloat; with the increased size and power of the transatlantic steamers, this seems to be the only way in which the present high grade of safety may be kept up. The steamships of to-day are as safe as they are swift, their designers having provided them with every requisite in case of danger. The steamship La Champagne, some years ago, was run into in the English channel, and several of her compartments were torn open and filled with water at once. In spite of this fact, she was able to reach port with comparative ease, and with no loss of life or inconvenience to her passengers. The use of water as ballast has grown greatly in favor with English designers, and has entered largely into the designing of their big steamers. Only with it, it seems, can British-built ships be rendered stable. Mr. Charles H. Cramp, the American shipbuilder, thinks differently, and with very good reason. He says: "Any system of design or construction which contemplates the carriage of water ballast (or other dead weight not cargo or coal) as an inseparable condition of stability under any circumstances is radically defective, and should be condemned. Of course every double-bottom ship should be so compartmented that the spaces may be used as trimming tanks for regulating fore and aft trim when desired, but I utterly reject and condemn any system under which they must be viewed as necessary adjuncts to stability. Under such a system no advantage can be taken of decreased draught caused by consumption of coal or absence of cargo, but the ship must always be kept down to a load draught in order to stand up. This is a purely English fad, and the English designers stick to it with characteristic tenacity." Mr. Cramp's superior judgment has been amply demonstrated, in that the performances of the St. Louis and St. Paul show them to be far stiffer and more stable, and that they roll less, than any ships in the transatlantic service. There are various improvements now in use on all first-class passenger and cargo steamships which have come to stay. One of these is the use of hydraulic power for the working of windlasses and other machinery, etc., on board a ship, such as the opening and closing of water-tight doors, the working of the doors of the boilers, etc. Steam steering-gear has proved an important adjunct in the equipment of a steamship, while forced draft and electricity for lighting and ventilating, and refrigerating machines for the keeping of perishable articles of food, etc., are hardly likely ever to be abandoned.

THE COST OF RAILROAD CONSTRUCTION.*

By John F. Wallace.

THE factors which determine the cost of railroad construction are varied, and are affected by local influences and time conditions. Railroads have been built across the prairies of the States lying between the Alleghany and Rocky mountains that did not involve a cash outlay, including equipment, exceeding $15,000 per mile. On the other hand, trunk lines have been built between important cities, some sections of which have cost as much as $100,000 per mile.

Railroad construction in the United States might properly be divided into three distinct classes, as follows:

First: trunk-line construction,—that is, construction of lines between prominent cities, with everything up to the standard of the American trunk line railroads. The average cost per mile of a line of this character at the present time would be approximately as follows:

Right of way	$ 2,000.00	Water supply, station buildings, round-houses, etc.	$ 1,200.00
Bridges and culverts	4,000.00	Engineering	700.00
Graduation	12,000.00	General and legal expenses	600.00
Ballast	3,000.00	Proportion of terminals	5,000.00
Track material and laying	7,000.00	Equipment	4,000.00
Fencing	400.00		
Telegraph	250.00		
			$40,150.00

East of the Mississippi valley this estimate would be increased by additional cost under such items as right of way, bridges and culverts, graduation, etc. West of the Mississippi valley, in the mountainous country, the cost of bridges, culverts, and graduation would be increased in the construction of long trunk lines, and the cost of terminals would be diminished. This sample estimate, however, will fairly show the average cost of the ordinary trunk line in the central portion of the United States. To this amount should be added the cost of financiering, which is not usually taken into estimates of this kind; experience in railroad promotion has shown that new lines necessarily have to dispose of their securities at a discount, whereas interest has to be paid on the face value. A discount of 10, 15, or 20 per cent.

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* It is proper to say that whereas the estimates of cost here given are necessarily approximate, they are, nevertheless, prepared from exact data as to the actual cost of railroad construction in various parts of the United States. In other words, Mr. Wallace is both a distinguished and a practical engineer, and for that reason his estimates may be accepted as a safe guide for both railroad officials and railroad investors.—THE EDITOR.

on the bonds of an enterprise of this kind is not unusual, which would increase the above cost to approximately $50,000 per mile.

Second: main lines of roads which do not form parts of through trunk lines, but which connect towns and cities of secondary importance, and upon which alignments and grades can be adopted that will admit of economical construction. A sample estimate of the average cost per mile of a line of this character, under present conditions, would be substantially as follows:

Right of way	$ 1,500.00	Fencing	$ 400.00
Proportion of terminals	1,500.00	Water supply, station buildings, round-houses, etc.	800.00
Bridges and culverts	2,500.00	Engineering	500.00
Graduation	6,000.00	General and legal expenses	400.00
Track material and laying	6,500.00	Equipment	2,500.00
Ballast	2,500.00		
Telegraph	250.00		
			$25,350.00

Third: branch lines,—that is, lines tributary to existing railroads, comparatively short, whose function is simply to bring passengers and freight to junction points with main lines, to do which two passenger trains and possibly three or four freight trains daily would fulfil maximum requirements; lines on which, also, heavier grades and sharper curves can be used, where desired, in order to lessen the cost of construction without materially increasing the cost of maintenance and operation. The average cost of a line of this character would be about as follows:

Right of way	$ 1,000.00	Water supply, station buildings, round-houses, etc.	$ 500.00
Proportion of terminals	500.00	Engineering	400.00
Bridges and culverts	1,500.00	General and legal expenses	200.00
Graduation	3,000.00	Equipment	1,500.00
Track material and laying	6,000.00		
Fencing	300.00		
Telegraph	200.00		$15,100.00

We may now consider the different items in detail.

Right of Way. The value of right of way depends, of course, on local conditions. For a single-track branch railroad, in a comparatively level country, from 50 to 66 ft. may be sufficient. On a low-grade trunk-line railroad, with high embankments and deep cuttings, with the probability that second and additional tracks will be needed later, from 100 to 200 ft. is generally required, and at important embankments and cuts still more. In the construction of lines across prairie country, where the building of the road will be of more or less local benefit, donations of right of way are frequently made, or the prices modified. Under ordinary circumstances, however, the average cost of right of way will be substantially double the usual local market value of the real estate. But, when it is necessary to secure a right of way in a thickly-settled portion of the country already under cultivation and well supplied with railroads, and where the property is cut diagonally, it is frequently necessary to pay four or five times the ordinary local value of the real estate actually occupied by the right of way; and it is sometimes necessary to purchase more land than is actually required, in order to make satisfactory settlements. It is true that the right of condemnation can be and is frequently utilized, but this mode of obtaining possession restricts the use of the property to railroad purposes. The best railroad managers prefer a deed in fee simple.

Bridges and Culverts. The cost of bridges and culverts will of course depend upon the local physical conditions of the country the line traverses, and upon the character of construction which the engineer in charge may determine upon.

Graduation. This item also is entirely dependent upon local physical conditions; the cost may vary from $1000 or $2000 per mile in prairie country and on branch lines where low grades are not essential, to many thousands of dollars per mile for main-line construction in rough country and where solid rock may be encountered.

Ballast. This item will vary from a few hundred dollars per mile for branch lines, where the ordinary soil of the country is frequently used for this purpose, to $1000 or $2000 per mile for gravel, according to the proximity of the gravel pits, and to $2000 or $3000 per mile for rock ballast, again according to the proximity of the quarries.

Fencing. This item is small and substantially uniform, regardless of the classification of the railroad, but is dependent upon local requirements, different States placing various interpretations upon the term legal fence.

Water supply, station buildings, round-houses, etc. This item, of course, varies largely with the classification of the road, the character of its business, and the ideas of the management as to what is proper and necessary.

Engineering. The cost of engineering, while comparatively a small item in itself, frequently affects the cost of the other items materially. The money appropriated for this purpose is supposed to be spent in securing the best obtainable talent, which is expected to determine the most economical means of accomplishing the purpose for which it is engaged,—*viz.*, the location and construction of a line of railroad which will be able to handle the greatest amount of business for the minimum of outlay, this outlay including, of course, interest on cost of construction, plus maintenance and operating charges. The cost of engineering is influenced by the ideas of the management, as well as by the ideas, economical or otherwise, of the chief engineer.

General and Legal Expenses. These vary, according to the personal qualifications and business ability of the promoters, from a small amount per mile for branch lines to the large amounts necessary in securing the construction of a line through a well-settled country, and particularly terminal facilities in large towns and cities, and in settling the complications and litigations that arise in negotiating with other railroads for connections and crossings.

Terminals. This element of expense is affected greatly by local conditions in the city where the terminal is situated.

Equipment. The cost of equipment depends not only on the character of the line, but also on the volume of its business.

Having touched upon the variations in the cost of the different items of railroad construction, due to local circumstances, it is now proper to mention the variations in cost that are due to time conditions,—*i. e.*, the variations in the cost of different items from year to year, as the result of the general development of railroad construction.

Right of Way. The cost of right of way is continually increasing year by year, as the country becomes more settled and land in consequence rises in value, and as the feeling of the necessity for additional railroad facilities diminishes in the minds of the general public.

Bridges and Culverts. The cost of bridges and culverts is continually increasing, due to :

(*a*) The fact that rolling-stock and equipment are increasing in weight. During the past 25 years the average weight of locomotives and loaded cars has doubled, requiring bridges and culverts of proportionately stronger construction.

(*b*) The facts that the ideas of engineers and railroad managers are tending towards stronger and safer structures, and that a surplus of material is being used in iron and steel structures, particularly on shorter spans than were formerly considered requisite to safety.

Graduation. The cost per cu. yd. of this item has been gradually decreasing, on account of the improvements in the methods and machinery adopted for work of this character. On the other hand, the quantity of material considered necessary for railroad construction has increased. In the past 20 years the standard cross section for embankments has been enlarged from 14 ft. to 18 ft. in width at sub-grade ; excavations, from 20 ft. to 28 ft.

Ballast. The cost of ballasting, more than any other item, is affected by local conditions, but has not been materially changed.

Track. Under the head of track is considered the cost of ties, which has been steadily advancing year by year. The cost of grade ties has been substantially doubled in the Mississippi valley in the past 30 years. This item is also affected by an increase in the quantity used, the number of ties to the mile having been increased on first-class roads from an average of 2640 to about 3000. As to rails, while it is true that there has been a steady and uniform decrease in the price of steel during the last quarter of a century, the average standard weight of rail for main lines has at the same time increased from 60 lbs. to 90 lbs. per yd., and the quality has materially depreciated. As an example of the deterioration that has taken place in quality, the writer may state that during the past year he has relieved from a main track on tangents rails that weighed 75 lbs. to the yd. which had been in the track only 5 years; whereas, on the same district and under precisely the same traffic conditions, there still remain in the track 60-lb. rails that have been in service for over 15 years, which it was not considered necessary to renew this season. While this may be an exceptional case, the writer considers the steel rail which was furnished by the manufacturers 15 to 20 years ago about 50 per cent. better than the rail now manufactured. This is not intended to apply to special high-class rails, which may be furnished by a few rolling mills under superior specifications, but to the ordinary rail supplied to and purchased by the majority of the railroads in the United States to-day. The reason of this inferiority hardly comes within the scope of this article.

Fencing and Telegraph. These items have remained practically unchanged during the last few years.

Water supply. As business has developed on the railroads, a larger and more constant water supply has become necessary, and tanks, wells, and reservoirs are now being constructed of much larger capacity than ever before. The capacity of tanks and pumping machinery has been practically doubled.

Station buildings. The increase in the cost of station buildings is not due to an increase in the price of material, but to the growing necessity for better accommodations for the travelling public arising out of a natural increase in business.

Round-houses and other structures. The cost of round-houses is substantially the same, except for an increase due to the demand for additional facilities, improved smoke-stacks, more expensive engine pits, turn-tables, etc.

Engineering. The cost of this item has been substantially the same during the past 20 years.

General and legal expenses. These have greatly increased in late years, due to the many new complications that are constantly developing in railroad construction, as population and railroads increase.

Terminals. The expense of railroad terminals is rapidly increasing year by year, because of the growing density of population in cities and the fact that the earlier railroads occupy the most advantageous positions.

Equipment. The cost of equipment is practically the same as it was a quarter of a century ago. While engines have been increased in size and weight, cars in strength and capacity, and coaches and sleepers in elegance and accommodation, a corresponding decrease has taken place in the price of the material and machinery used in their construction. There has also been a fierce competition between large corporations engaged in the manufacture of different articles of railroad equipment, which has had an influence in lowering prices.

In the foregoing estimates and remarks two items of considerable importance have been mentioned, which we may consider further.

The cost of railroad construction has been materially increased of late by the necessity of providing crossings for the new lines over existing roads. In the earlier years of railroad construction, if the junior road would agree to put in the crossing frogs and maintain them, the senior road was satisfied. Now the senior road frequently requires the junior road to construct its line over or under the existing road. The expense of a crossing of this character varies from $10,000 to $100,000, according to local conditions. Even if an over- or under-crossing is not insisted upon, expensive interlocking plants are required, which entail additional burdens on the new road, not only in the first cost of construction, but in operation and maintenance as well.

The most important item of cost in railroad construction, however, is that of terminal expenses in the larger cities. This expense has now become so great in the leading cities that new roads usually prefer to rent their terminal facilities from existing lines. In Chicago to-day there are roads paying a rental for terminal facilities—and restricted terminal facilities at that—equal to the interest on $10,000,000. In order to emphasize the importance of this item, the writer will assert that, if a new line of railroad were built from Kansas City to Chicago by way of St. Louis, with adequate independent terminal facilities in these three cities, the cost of the terminals would be in excess of the cost of the remainder of the road, fully equipped.

The total cost of railroad construction is continually increasing year by year. While some items may have been cheapened on account of the lower price of material or labor, or by competition, other items are increasing in much larger proportion ; and the public requirements of safety, speed, and convenience are steadily adding items of cost which in former years were not considered necessary,—among them, superior character of the road-bed, block and interlocking signals, air brakes, patent couplers, special cars for high-class products, etc.

SCHOOLS AND SCHOOL-HOUSE ARCHITECTURE.

By E. C. Gardner.

THE earth rests upon an elephant, and the elephant stands upon a tortoise : that is a fable. Our own country rests upon public schools ; upon universal homogeneous, free, public education : that is fact.

Since the first requisite of good architecture is adaptation of means to end, the use and importance of public school-houses must be fully appreciated before they can be wisely planned. Especially is it incumbent on those who are responsible for the buildings—not architects, but city governments and their commissions, superintendents, and school boards—to have a clear perception of whatit means to build a school-house. These buildings are not luxuries, but necessities ; they should not be postponed till indispensable, but the supply should precede and stimulate the demand ; instead of the time being near at hand when we shall have enough for present and future need, we are but just laying the foundations. To increase the terror of the unwilling tax-payer, it may be affirmed that, of the school-houses built 25 years ago, not to mention many of more recent date, a large portion are so illy adapted to their use, so poorly lighted, so badly ventilated and plumbed, so imperfectly heated, so unfavorably located, in a word, so unsanitary in some one or more important particulars, that their destruction would be an actual benefit, provided, of course, they were replaced by something better.

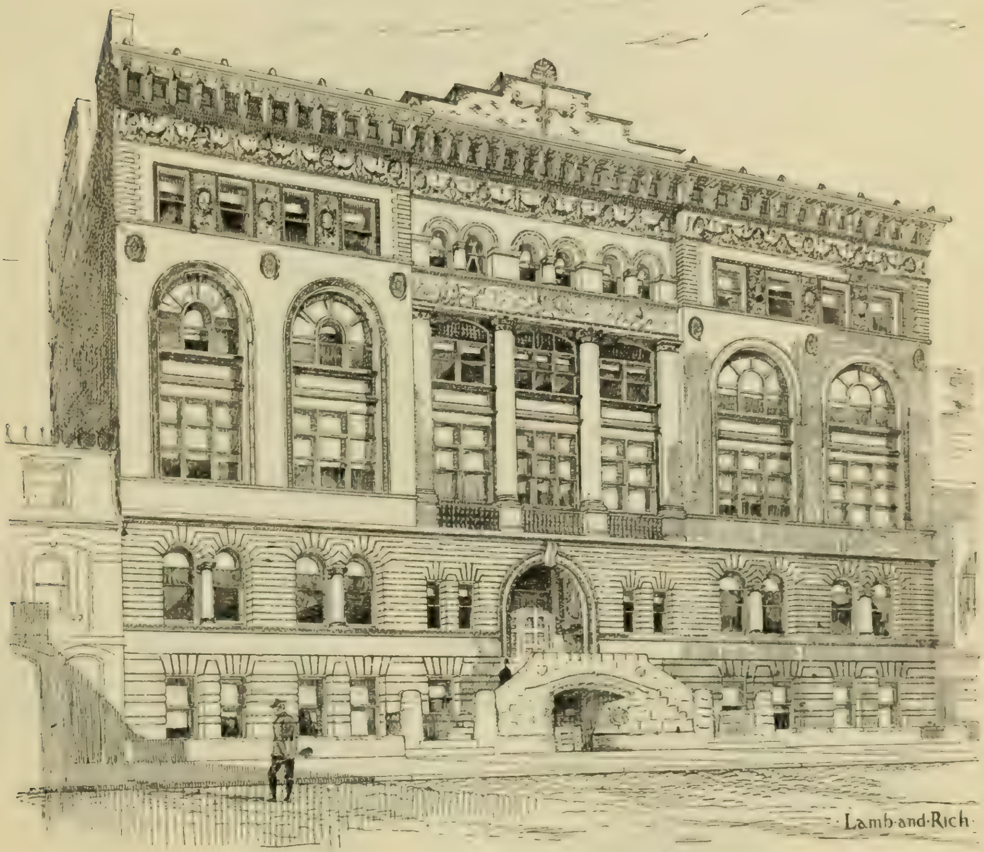
" It is my opinion," said the principal of the largest public school in one of our great American cities, " that all our school houses should be built with the distinct understanding that they are to be destroyed at the end of 20 years,—25 at the farthest. Our old buildings, stand stubbornly in the way of changes that must come sooner or later, many of which would come at once, if it were not found expedient and economical to adapt the school to the house rather than the house to the school."

That is perhaps one extreme. The other was expressed in a recent address before a teachers' convention in the Connecticut valley, in which the president of one of the eastern colleges urged that "every school-house should be a veritable palace."

The average citizen would hardly vote for the destruction of a palace, and, if we build palaces, we must be prepared to keep them ;

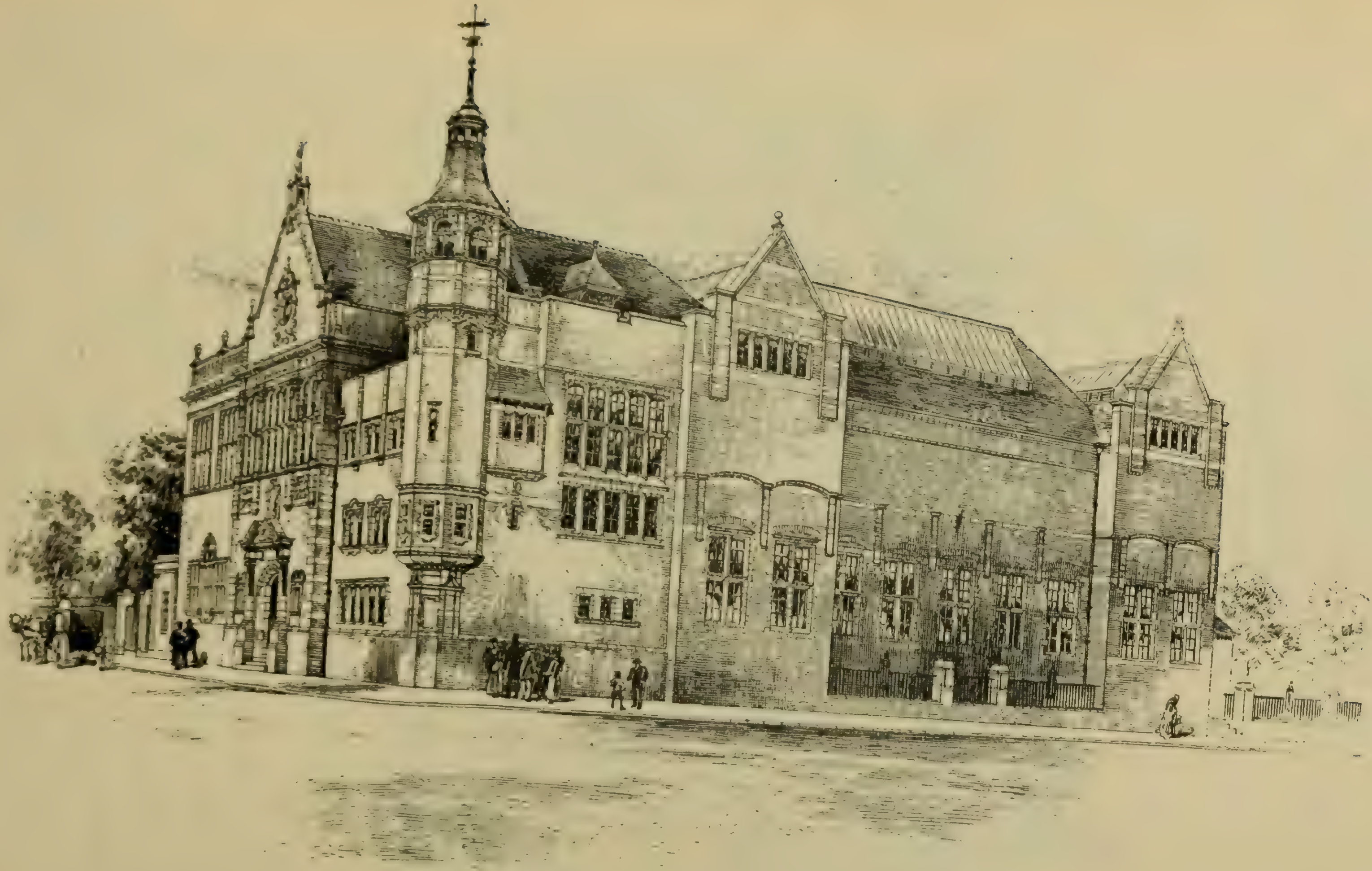
although, for the better education of the children, the occasional spoiling of a palace would be less foolish and wasteful than many of the follies committed by municipal authorities in the way of public architecture.

If the safety, health, and highest good of the children are best achieved by means of palaces, let us have palaces; but, before crippling our resources for years to come in order to erect a palatial building, largely by way of monument to the administration that "carries it through," it is well to be sure that its conservative magnificence will not prove a stumbling-block to its usefulness. The readiest compromise would be to see that every large school-house, whether palatial or otherwise, shall have a site large enough for indefinite modification and growth. For, once occupied, a poor site is an incurable evil, whether its fault is of size or environment. Even a low, damp situation is not so objectionable as a lot too small or shut in by unfa-



BERKELEY SCHOOL, FORTY-FOURTH ST., NEW YORK.

Lamb and Rich, Architects.



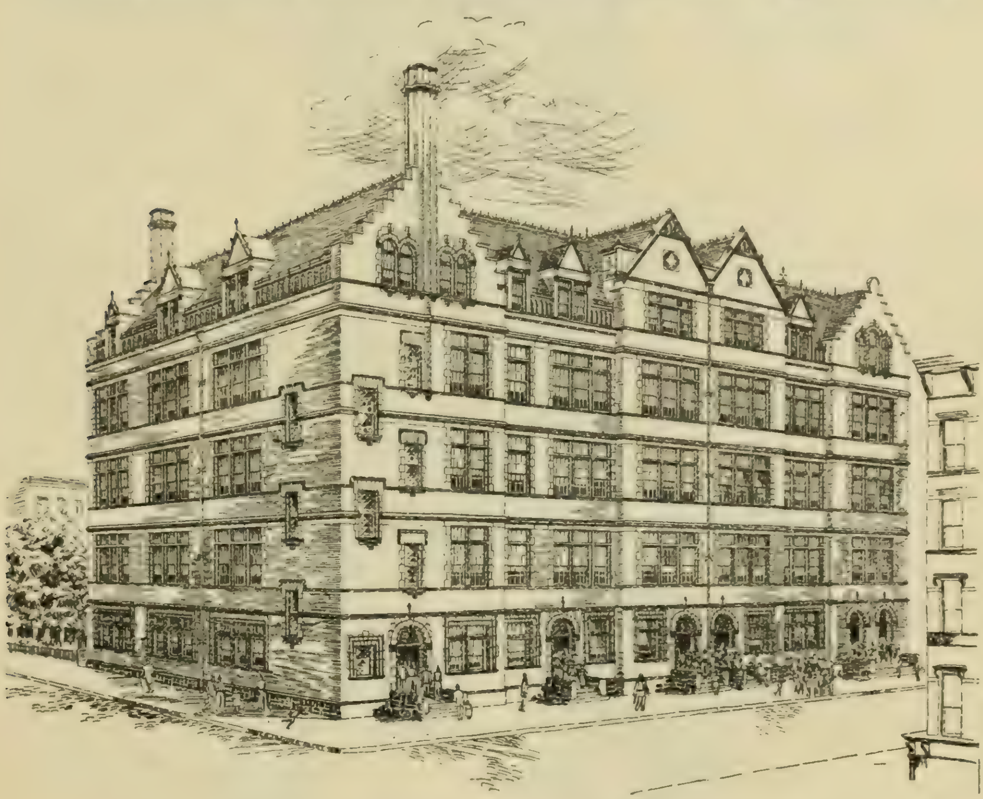
THE VICTORIA INSTITUTE, WORCESTER, ENGLAND.

J. W. Simpson and E. J. Milner Allen, Architects.

vorable surroundings, for it may be drained and converted into salubrious, solid ground.

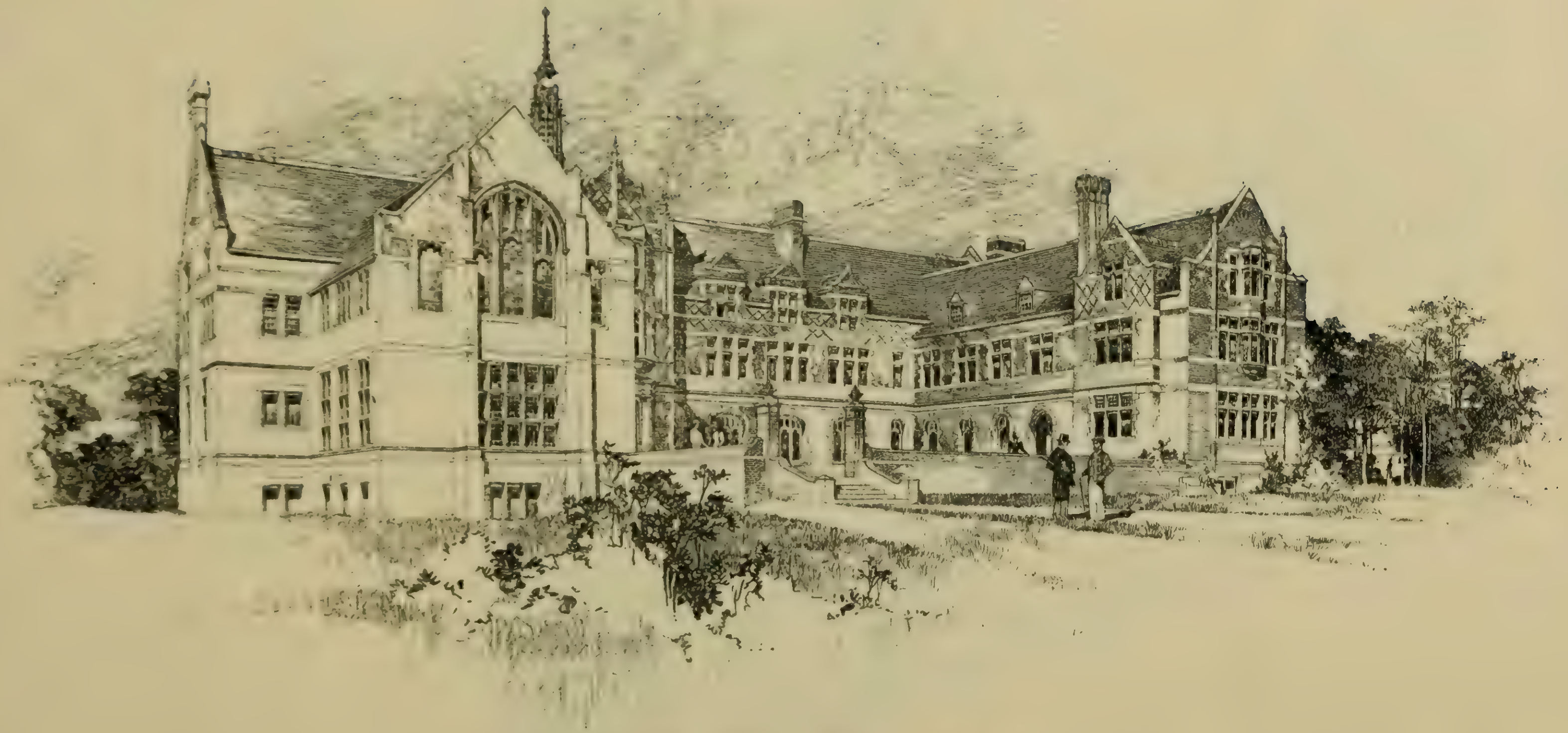
When plans for a school-house are unfavorably modified to suit a limited site,—and this occurs more frequently than I would dare to intimate,— the building is permanently damaged, and, before building, the question should be asked and unflinchingly answered: "Would the proposed plan be adopted, if the lot on which it stands could be enrlaged at will?" Something is positively wrong, if this must be answered negatively.

There are various matters relating to the general organization of schools which also concern the plan and about which the doctors differ.



SCHOOL-HOUSE, FIFTY-EIGHTH ST. AND MADISON AVE., NEW YORK.
C. B. J. Snyder, Architect.

"What is the largest number of pupils that may be placed in one high school without disadvantage?" was one of several questions addressed to about fifty prominent educators in the United States from New England to California. Seventy-five per cent. of the replies suggested from 800 to 1000; 20 per cent. would limit the number to 600; and the remainder would not fix a limit, accepting several thousands, if properly managed. Another question was whether, in case



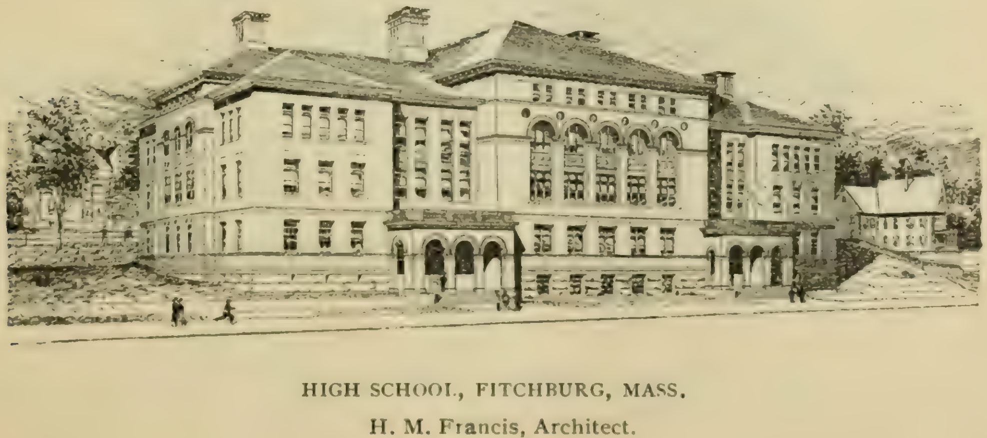
STATE NORMAL SCHOOL, JAMAICA, NEW YORK.

Cram, Wentworth, and Goodhue, Architects.

ENGLISH HIGH SCHOOL, CAMBRIDGE, MASS.
Chamberlin & Austin, Architects.

of a school of 800 or more, the preference would be for one large sitting or study room for the entire school, with numerous recitation rooms; for two such rooms; or for a sufficient number of small sitting rooms, in which the teacher could conduct her own classes. More than 75 per cent. distinctly preferred the separate class rooms to hold not more than 50 pupils each, a few limiting the number to 35 or 40, with a similar number of smaller rooms for recitations; and the remainder suggested different arrangements, no two being alike.

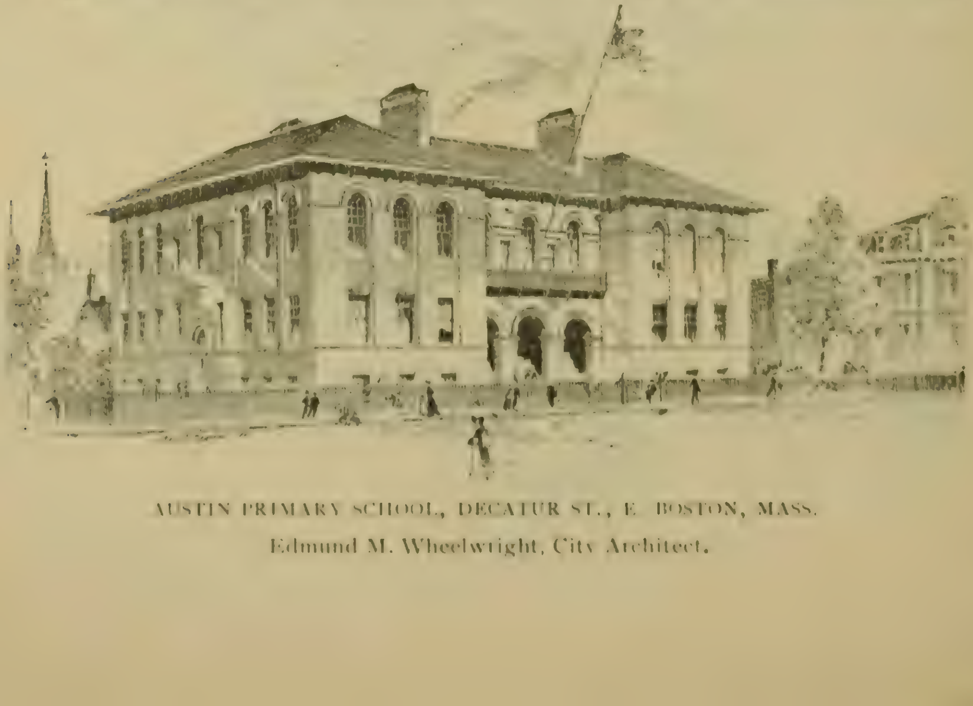
Other inquiries relating to the situation of the assembly hall, if there is one, to the chemical laboratories, and to heating and ventilation, brought still more varying replies. In certain parts of the country the separation of the sexes in at least some of the grades is preferred, and some would restrict the height of the buildings to one story above the basement.



HIGH SCHOOL, FITCHBURG, MASS.
H. M. Francis, Architect.

PRIMARY SCHOOL HOUSE, JAMAICA PLAIN, BOSTON, MASS.
Edmund M. Wheelwright, City Architect.

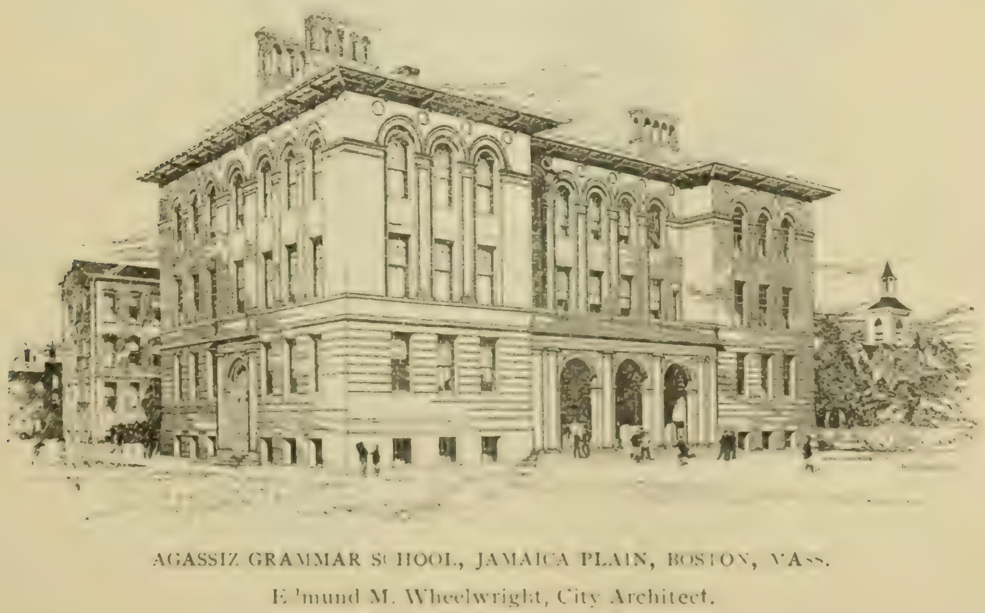
All these elements relate to the general plan. In minor matters there is a like variety of opinions. That the principal light for the class rooms shall be from the left of the pupils is admitted, but whether that shall be the only light is a point on which good authorities differ, although it is not maintained now, as it was in some countries a few years ago, that windows must be restricted to one side. In fact, unilateral lighting is now prohibited in some parts of Europe. Common sense would decide the matter quickly enough, if it were a question of light in a factory or business office. A long and narrow room may



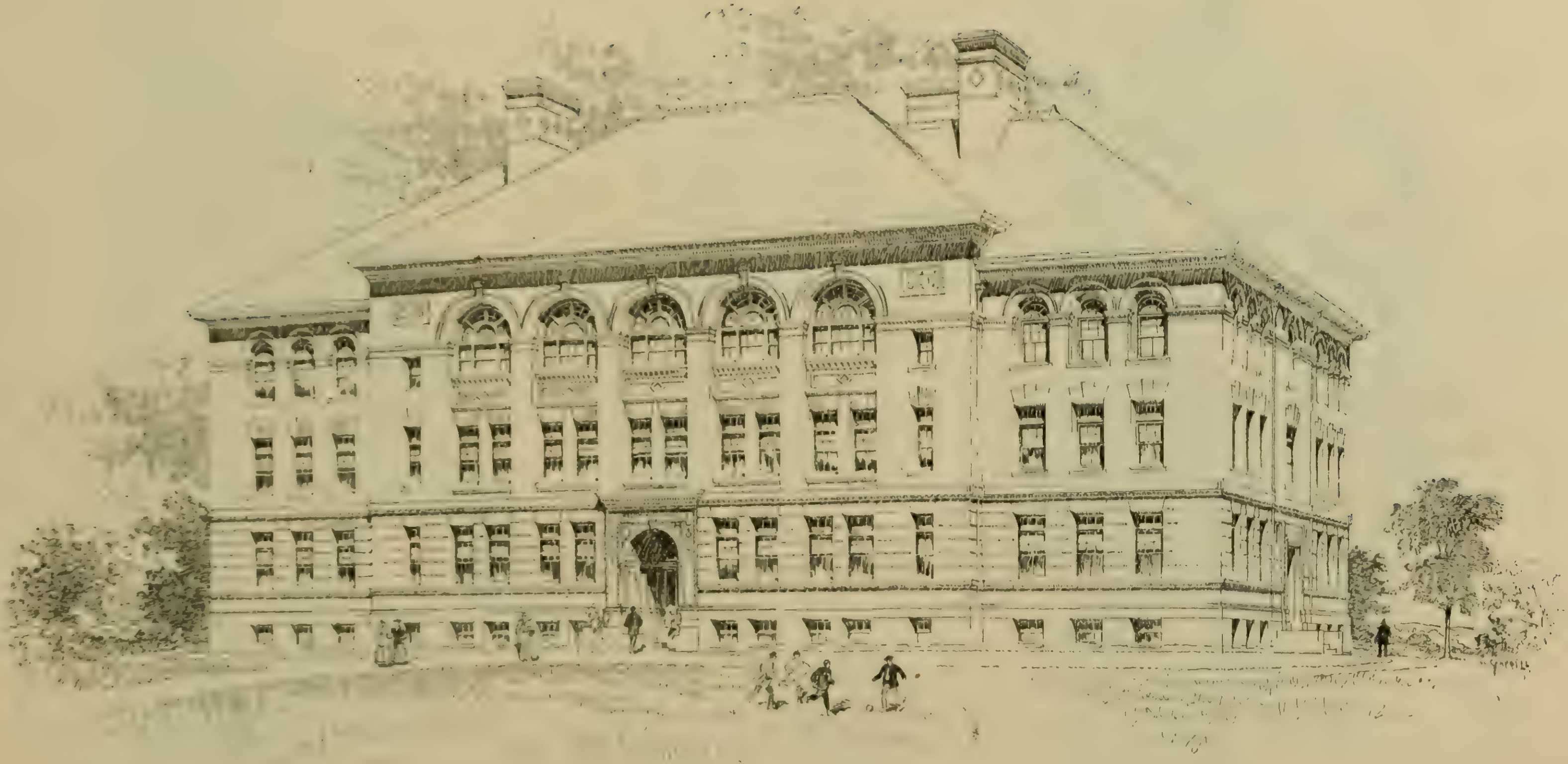
AUSTIN PRIMARY SCHOOL, DECATUR ST., E. BOSTON, MASS.
Edmund M. Wheelwright, City Architect.

ROBERT GOULD SHAW GRAMMAR SCHOOL, WEST ROXBURY, MASS.
Edmund M. Wheelwright, City Architect.

be well lighted by windows in one of the long sides, but it would be impossible to light a square room of the same area by light at one side, unless its height is greatly increased,—still less an oblong room by windows in one end. Whether the external beauty of the building will be marred by placing the windows in the most advantageous situation for the interior will depend upon the skill of the architect. But there would still remain the alternative between disfiguring the building and injuring the eyes of the children.



AGASSIZ GRAMMAR SCHOOL, JAMAICA PLAIN, BOSTON, MASS.
Edmund M. Wheelwright, City Architect.



HIGH SCHOOL, SOMERVILLE, MASS.

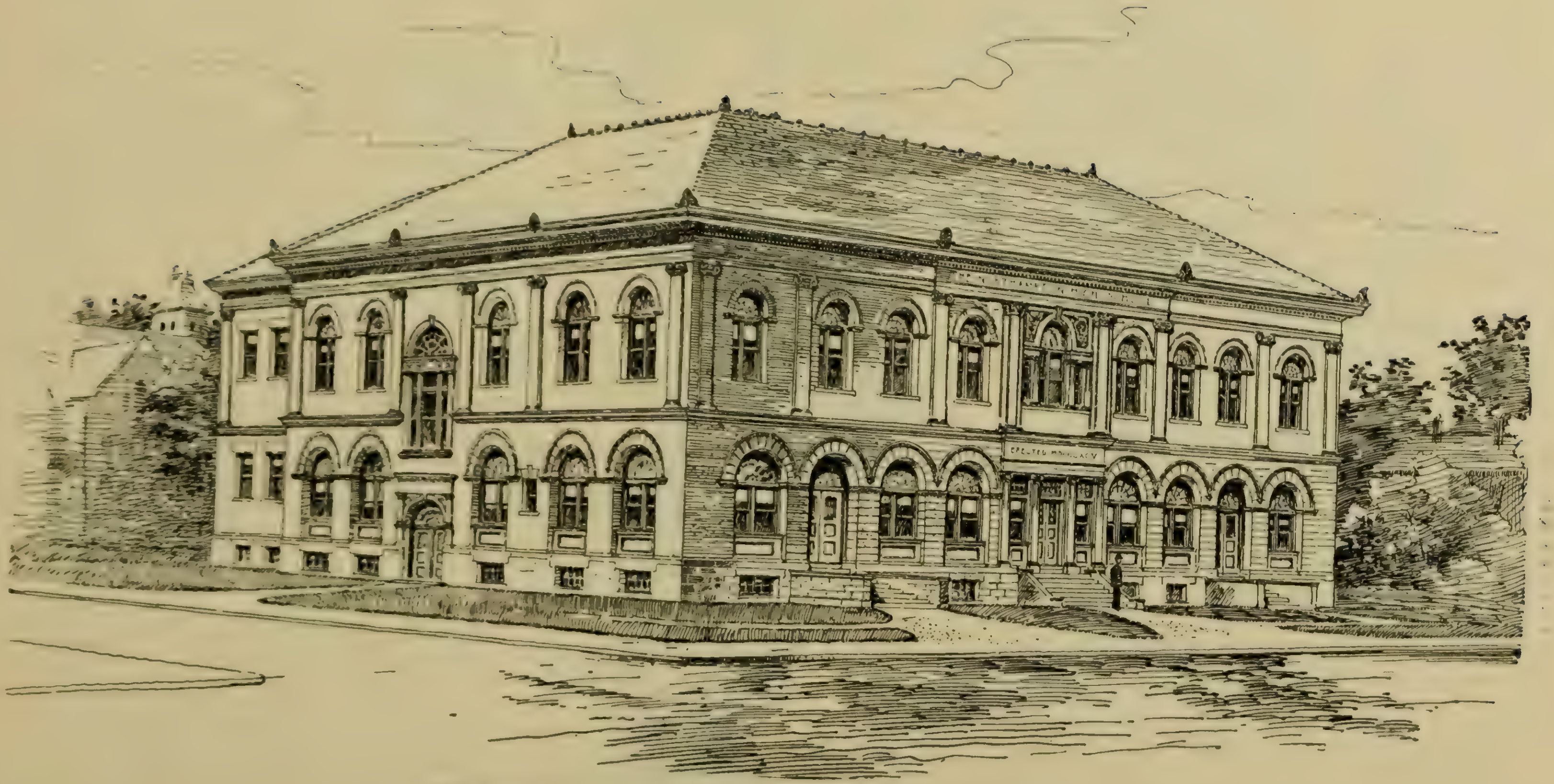
Hartwell, Richardson, and Driver, Architects.

The proper height of the average class room is debatable; but this also calls for common sense. If lighted from one side, only, the wider the room, the higher it should be. Speaking generally, the height should be equal to half the distance of the windows from the opposite wall, if there is to be good light upon the blackboards and the row of desks farthest from the windows.

The coat rooms are subjects for controversy. A separate room for each sex adjacent to each class room and communicating with it is a favorite demand; large frames 6 or 7 ft. high and of various lengths, set 3 or 4 ft. apart on the floor, carrying hooks for hats and outer wraps, with shelves or boxes for overshoes, the whole resembling cattle stalls or sheep racks, are often placed in the halls, vestibules, and corridors, which are enlarged to accommodate them. Similar screens placed near the entrances to each class room and forming what might be called wardrobe vestibules between the corridors and the class rooms are approved in Boston; while sentry boxes, with flexible doors to be closed when the boxes are full, and which may be placed in any desired location like Saratoga trunks or rolltop desks on end, are supposed to be capable of bottling up the effluvia from damp clothing until it can be removed through ventilating flues.

LABORATORY AND GYMNASIUM, THAYER ACADEMY, S. BRAINTREE, MASS.
Hartwell and Richardson, Architects.

Another mooted point is the proper location of the toilet rooms. There are those of long experience and good judgment who would put in the basement all except those for the exclusive use of teachers. Others, equally wise and good, would have them in a separate wing, connected by open corridors to the main building. Still others would make provision for each sex on each floor; and many of no less common sense and discrimination would distribute them through the building, in the ratio of perhaps two groups on each floor for every hundred pupils.



THE NORTHAMPTON HIGH SCHOOL, NORTHAMPTON, MASS.

Gardner, Pyne, and Gardner, Architects.

Varying conditions might make one or another of these methods preferable in a given case; in the main they are questions of opinion, and should be determined by those whose wishes are to be regarded.

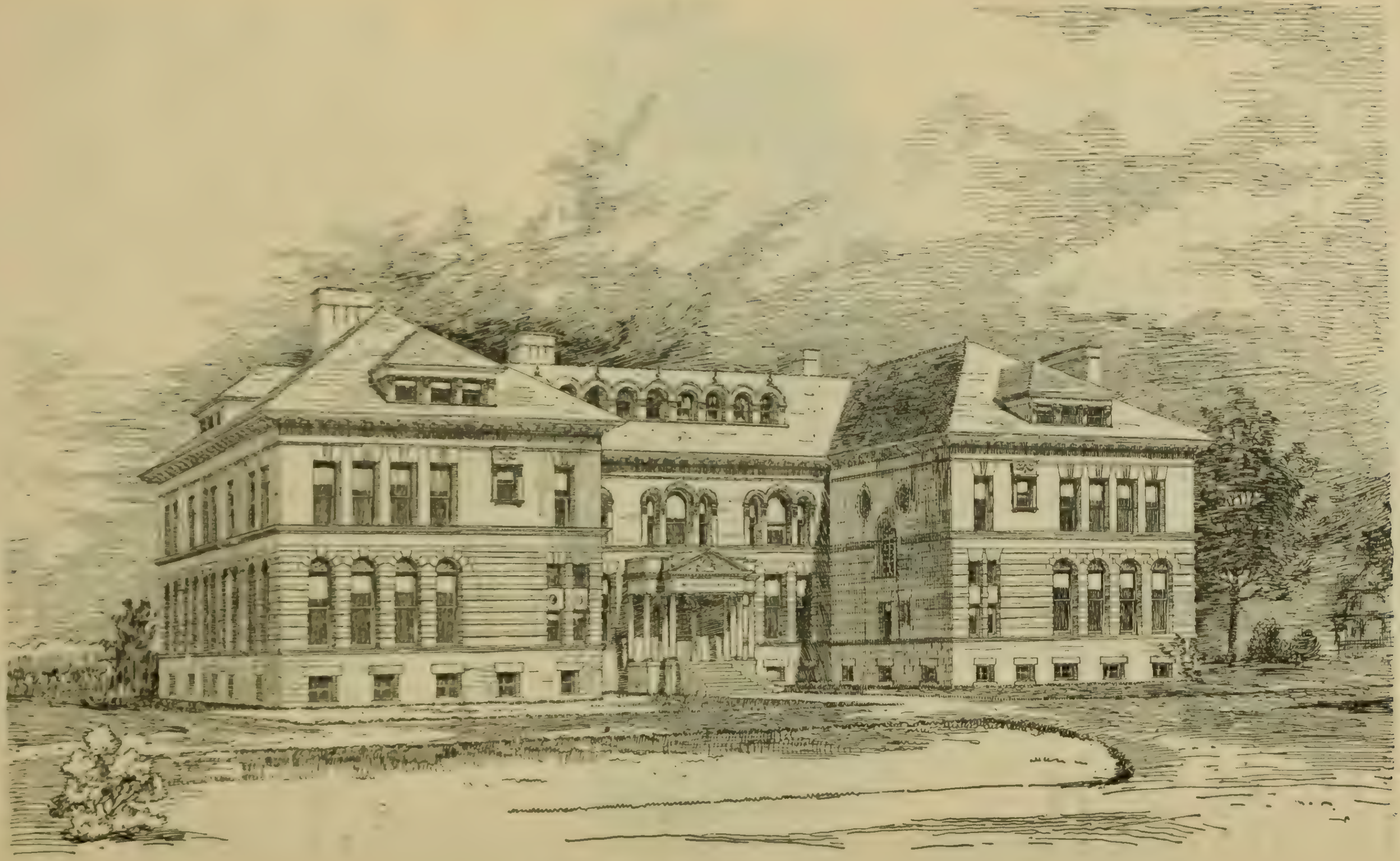
Then come matters of course. Certainly the coat rooms must be light, dry, warm, and well ventilated, and so arranged that each pupil can take his own without disturbing the rest. It is not necessary that he should be able to take a flying leap from the class room to the outer door, catching his hat as he flies. There is no serious objection to his crossing a corridor, or even the width of the building, if by this means better order can be maintained. In arranging corridors and passages, it should be borne in mind that mere distance is of slight consequence in comparison with conflicting routes in passing to and from recitation rooms. Corridors should have ample light and should be well ventilated, but it is not necessary in cold weather to keep them as warm as the class rooms.

THE WARD FOUR SCHOOL HOUSE, SPRINGFIELD, MASS.

Gardner, Pyne, and Gardner, Architects.

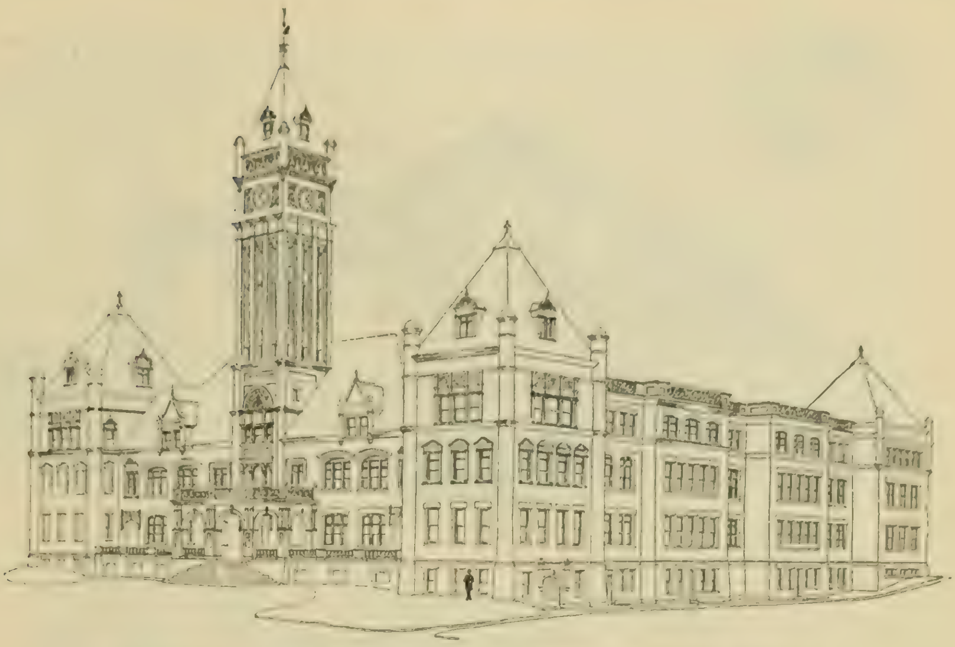
Stairs should be wide, and of gradual ascent. It may be true that most children climb stairs with the same apparent ease that squirrels climb trees, but this is not true of all; and, to avoid the danger of falling, either with or without the impetus of a panic, the grade should not exceed 22½ degrees.

In all class and recitation rooms, at the teacher's end of the room and on the side opposite to the principal windows, all the available wall space to the height of 6 or 7 ft. should be covered with blackboards, preferably of natural slate.



DESIGN FOR A NORMAL SCHOOL.

Gardner, Pyne, and Gardner, Architects.



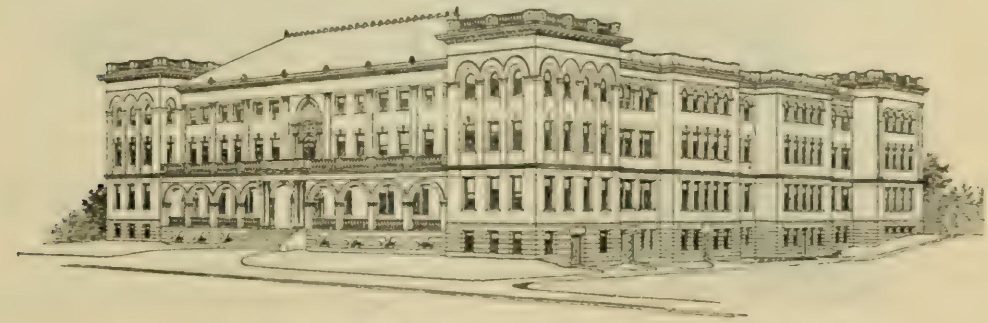
A.—DESIGN FOR A HIGH SCHOOL. AN ALTERNATIVE FOR "B."

Gardner, Pyne, and Gardner, Architects.

The windows should extend from about 3 ft. above the floor to within 6 or 8 in. of the ceiling. They should not have semi-circular tops or heavy wood or stone transom bars. They should be furnished with double shades, one set to be drawn up from the bottom, the other to be pulled down from the top.

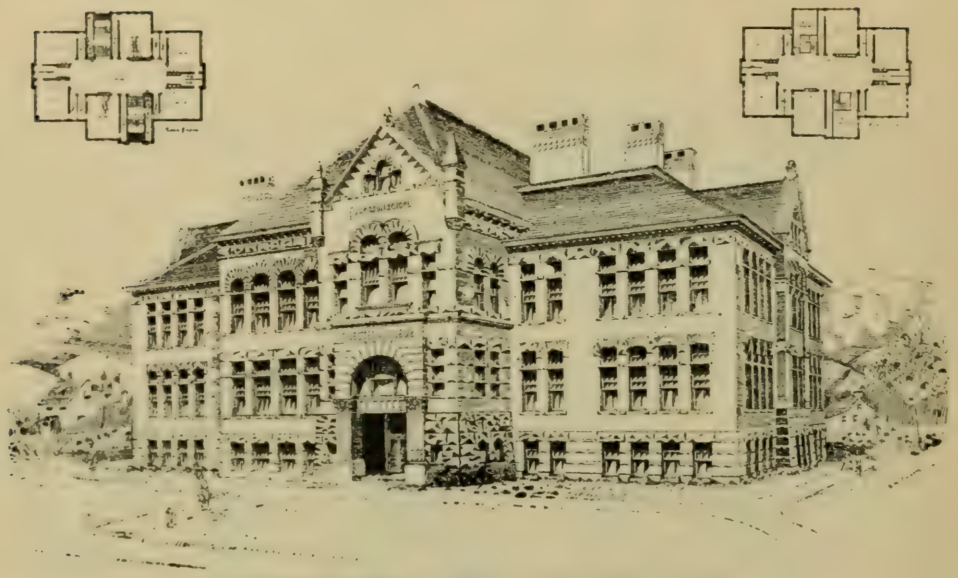
Floors should be of hard wood so well seasoned that there will never be any visible cracks in them, and the upper floor should be thick enough to hold securely the screws that confine the desks and chairs,—no trifling matter, for the growing length and strength of boys are not easily restrained.

If wood wainscot is used on the walls where there are no blackboards, it should be entirely plain. With suitable backing a hard



B.—DESIGN FOR A HIGH SCHOOL. SAME GROUND PLAN AS "A."

Gardner, Pyne, and Gardner, Architects.



JACKSON SCHOOL, SALT LAKE CITY, UTAH.

Ware and Cornell, Architects.

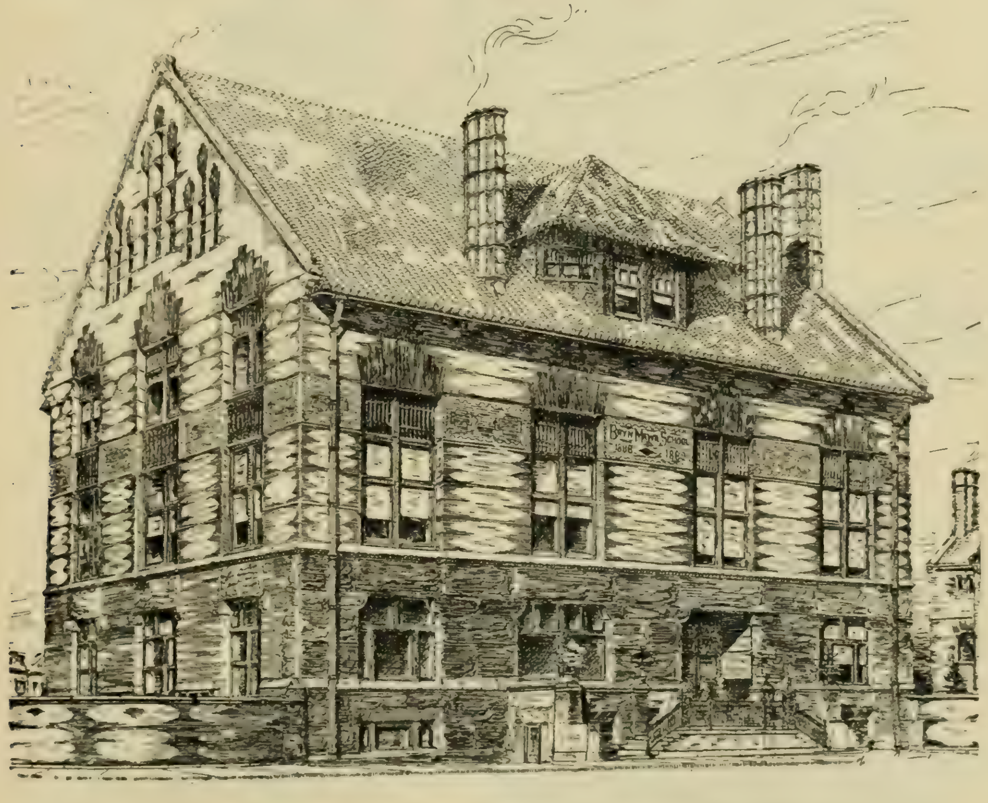
cement wall, thoroughly painted, is cleaner and more durable than wood. Instead of the common plastering of lime and sand, some one of the many good cements should be used for all the plastered walls and ceilings, and all the corners and angles should be rounded.

Not the wainscot alone, but all the wood finish should be of the simplest style: if it can be dispensed with wholly, all the better. Whether considered from the esthetic or the sanitary point of view, harmoniously-tinted walls with plain painted pine finish are infinitely preferable to the most pretentious oak "trimming" on glaring white walls.

DAY SCHOOL BUILDING, SEATTLE, WASH.

J. Parkinson, Architect.

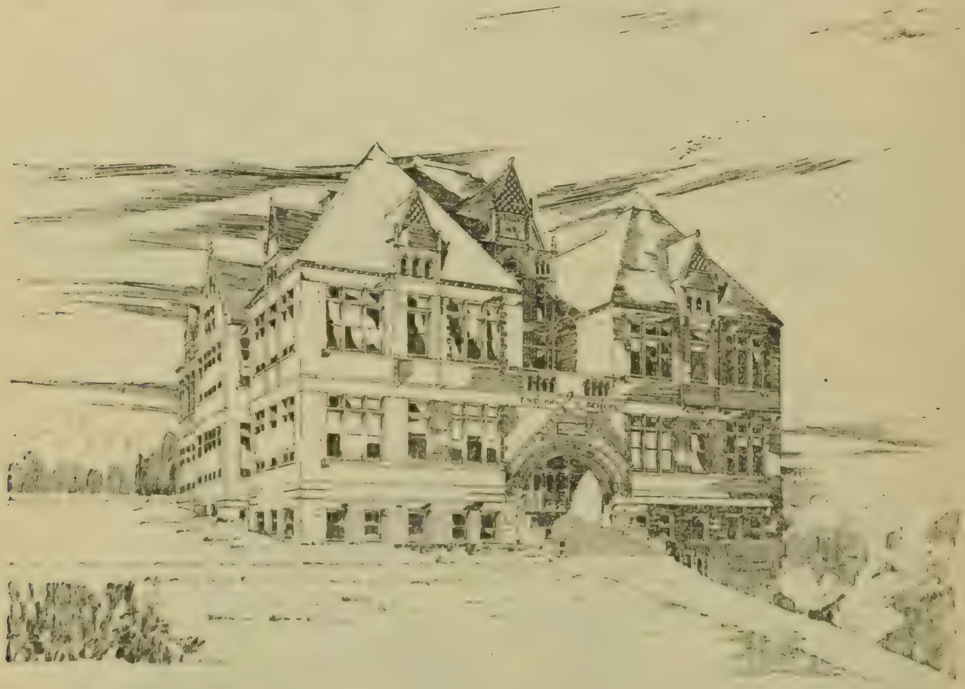
It is possible to use wood in really artistic forms; but the inevitable compromise between economy and art is, like most compromises, a failure both ways. Examples of real architectural and decorative art may be had even in the humblest school-house, but elaborate moldings and abortive carvings are not artistic, are not necessary, and for sanitary reasons are distinctly objectionable. Upon that ground their omission is perhaps as important as the abolition of slates, slate pencils, and sponges; the restriction of each pupil to the use of his own box of pens and lead pencils; the frequent changing of the paper covers of books that are used in common; the use of individual drinking cups; and the prompt disinfecting of rooms in which any pupil has been sick of contagious disease.



THE BRYN MAWR SCHOOL HOUSE, BALTIMORE, MD.
Henry Rutgers Marshall, Architect.

In the sanitary category stands also the providing of simple, healthful, and attractive-looking lunches, with the corollary that eating anything else, or at any other than the regular time, is prohibited.

Keeping still to sanitary matters, heating and ventilation by methods in common use are intimately related. Warm fresh air is easily introduced. I am not aware that warm foul air can be expelled from a room without the loss of the heat that it carries. Undoubtedly it ought to be. There is an amazing waste when air that is brought into a room fresh and warm, at the rate of 30 cu. ft. a minute for each of the occupants, is immediately driven out at the same rate and at a temperature only 2 or 3 degrees colder than when it was introduced. If this same method were adopted in all the buildings of large cities, our winters would be the warm season, or all the coal beds would be exhausted. As warmth is none the worse for being used, it would seem to be good thrift to keep the good heat and expel the bad air. What electricity may do in this direction remains to be seen ; it is not inconceivable that 10 years hence our present wasteful and complicated modes of heating and ventilation will seem as antiquated and unscientific as the famous method of preparing roast pig.



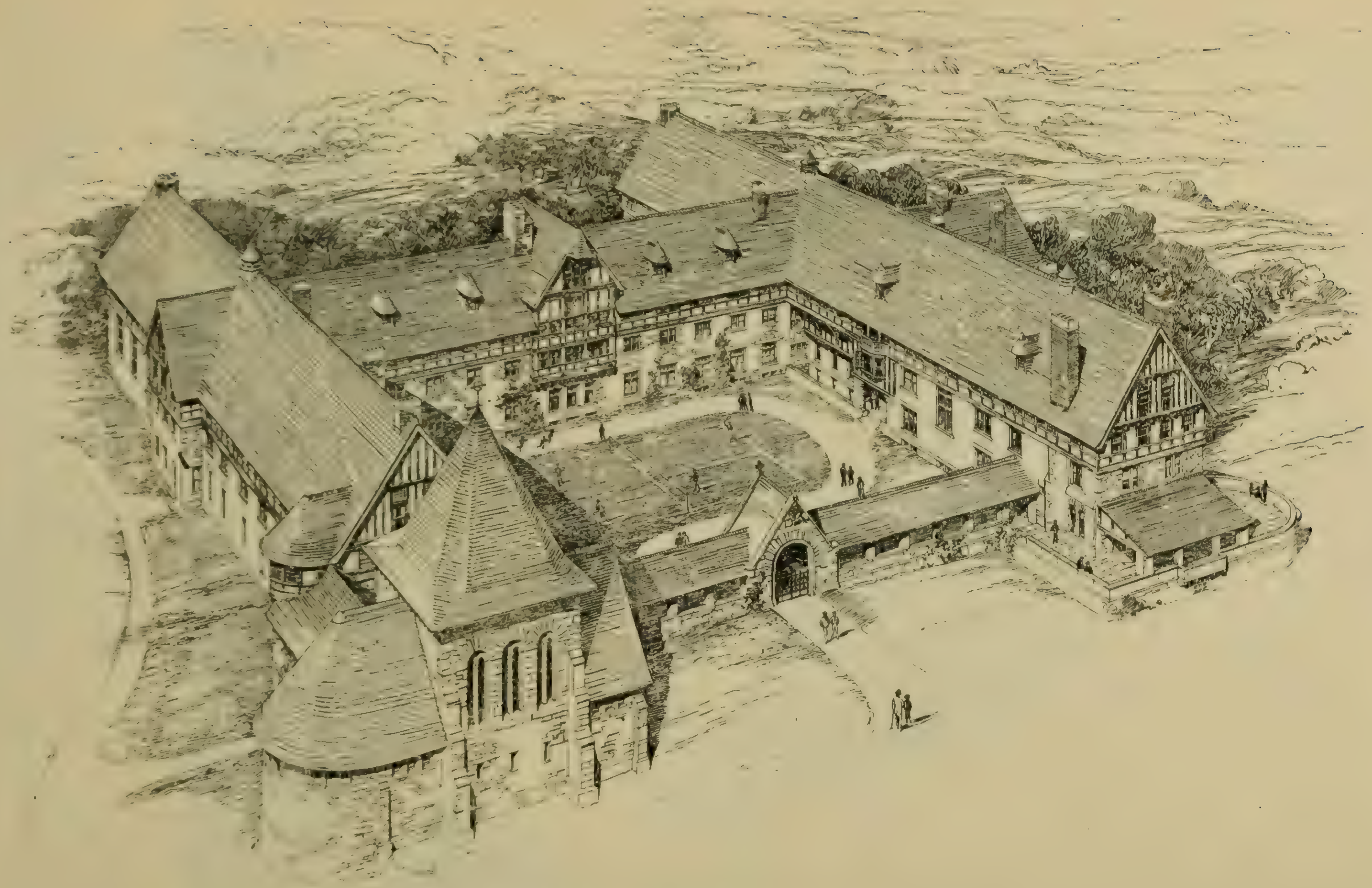
ENDION SCHOOL BUILDING, DULUTH, MINN.
Traphagan and Fitzpatrick, Architects.

Accepting the present manner of forcing warm fresh air into each room as the best attainable, there are still a right and a wrong way of doing it. As the warm air is sure to rise, or, rather, to be lifted to the top of the room, it may as well enter near the ceiling ; the incoming current will not be felt, and, if the exhaust is at the same side of the room near the floor, the entire atmospheric contents will be brought to a uniform temperature, and will be constantly changed. It is sometimes urged that the warm air should be driven into the rooms at the sides opposite the main window wall, so that, passing at once to the colder side of the room, it will fall to the floor and be withdrawn through a floor register underneath the point where it entered. Theoretically, and under favorable conditions of the wind, that may be right, but I believe the most carefully conducted experiments show that the best results are obtained when the circuit is, so to speak, parallel with the principal window wall rather than at right angles to it.

Among other heating equipments a sufficient amount of direct radiation should be provided for warming cold hands and feet and for the rapid drying of wet overclothing, including mittens and overshoes. The ventilation of the water-closets and other plumbing is of great importance, but it is less complicated than that of the class rooms, the one essential point being the rapid and certain removal of the air in the room. Stress is sometimes laid upon the need of outside windows for water-closets. For light they are desirable; for ventilation, quite the contrary. Placed in the center of a building with only an upward flue or outlet, the closet is virtually in the bottom of a chimney, and there is no danger that any adverse wind will drive the atmosphere of the room into other parts of the building; but outside windows, unless always closed, are liable to prevent, rather than aid, ventilation.

With the growing demands upon public schools, the basement is rising into prominence. It must be light, dry, well-ventilated, clean. It should contain at least a part of the toilet rooms; it should be easily accessible and have proper stalls for bicycles. It should contain rooms for informal gymnastics or other exercise, and lunch rooms of ample size. If a proper manner of eating is not an essential branch of a liberal education, it ought to be.

STATE NORMAL SCHOOL, STEVENS POINT, WIS.
Dwight H. Perkins and George Selby, Architects.

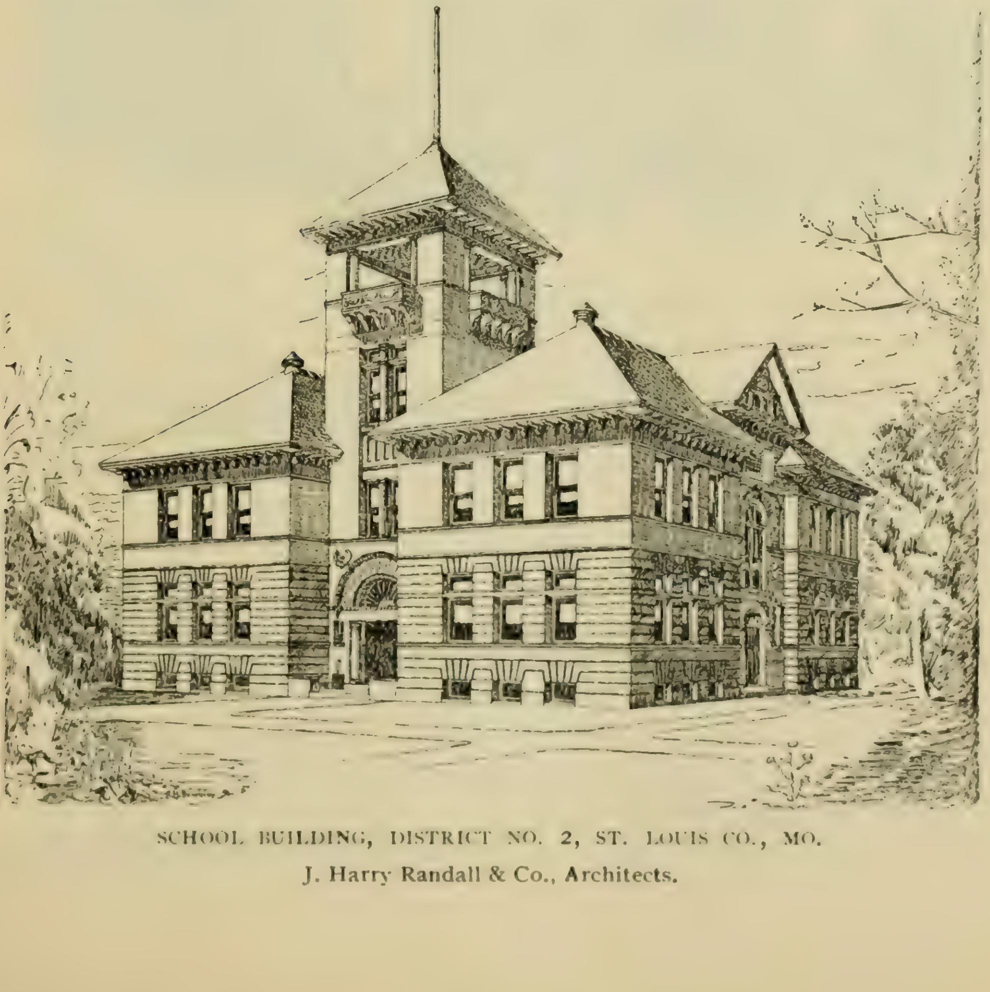


ST MARK'S SCHOOL, SOUTHBOROUGH, MASS.

H. F. Bigelow, Architect.

In addition to the recitation and class rooms, all large buildings should contain a library, a principal's room or suite of rooms, and one or more smaller rooms, furnished with whatever will make a comfortable resting-place for teachers during the occasional moments of leisure. Such rooms should have a special toilet room adjacent, and near the teacher's room there should be a small room for pupils who may be suddenly taken ill. Closets and store rooms for books and stationery, with lifts connecting the different floors, are in order, and large buildings three or more stories in height should have elevators adequate at least for teachers and pupils to whom climbing stairs is painful and injurious. Each class room should have cupboards with glass doors, and long drawers for maps and charts. In brief, there should be explicit provision made for the preservation and orderly handling of everything used in the school. There should be not merely picture moldings (which are often put up under the delusion that in themselves they are decorative), but good pictures. Brackets and shelves for casts, growing plants, and other appropriate ornaments are as legitimate school furniture as chairs and desks.

The construction of school houses should be absolutely simple and



SCHOOL BUILDING, DISTRICT NO. 2, ST. LOUIS CO., MO.

J. Harry Randall & Co., Architects.

durable. The chronic burden of bills for school-house repairs proceeds mainly from false economy and the employment of dishonest contractors and incompetent workmen. Whether a building should be fireproof is a financial question. If it is expected to serve two or more generations without change, it ought to be indestructible by fire, which means also able to resist the decay and deterioration that are inevitable when any part of the essential structure is of wood. A fireproof building is also to a great extent sound-proof. The floors of vestibules, corridors, and toilet rooms should be of tiles or marble and cement, and the fittings and dwarf partitions of the latter should also be of marble. The rooms containing the latrines and urinals should be of such construction that the entire room—floors and walls—may be freely washed with a hose.

KERSHAW SCHOOL, CHICAGO, ILL.

J. J. Flanders, Architect.

It is unfortunate that, while abundant land around school houses is easily obtained in the country and suburban regions, where it is the least needed, in cities, where open space is infinitely more to be desired, it is denied for economical reasons. But cities that can afford space for public squares, which in many cases are mainly occupied by idlers, ought to afford needful room for the well-being of the children. The public park is for show, which is good; the play-ground is for temporal salvation, which is better.

As for the visible architecture of school-houses, we shall have none that is good, until tradition and fashion are cast aside for utility. There are no public buildings for which money should be more freely spent, than for school-houses. Nowhere else is the highest architectural art more effective. It is also true that there is no justification for the apparently frequent assumption that it is well to spend freely on high schools, while anything that gives shelter from the elements will answer for the primary. If any children need more than others the beneficent influence of art and refinement in public schools, they are those to whom these things are elsewhere unattainable.

Without attempting to suggest appropriate "styles," it is clear that fitness, the cardinal virtue of all architecture, requires grace, lightness, and elegance, rather than solemnity, gloom, or even what sometimes passes for solidity and dignity. There is no doubt that the educational value of Richardson's work has been seriously impaired in many ways by his imitators. The architectural vagaries and aberrations which seem to have been borrowed from the decadence of the so-called "Queen Anne" are irrational and offensive. A beautiful tower as a civic ornament is a joy forever, and it may as well be attached to a high school as to any other public building. But the turrets and domelets and fantastic dormers and other roof excrescences that are applied for the sake of diversifying the "sky lines," or "relieving" some broad expanse of roof, have neither artistic nor educational value. There is much to be said in favor of flat roofs. Indeed, almost everything is in their favor from the utilitarian, constructive, economical, and sanitary point of view. Is the modern architect incapable of good composition and design without virtually disregarding these qualities?

After all, there is little hope that we shall have even good architecture, still less the best, while decisions concerning architectural merit are left to the authorities of the average city government, or, worse, to others who are liable to be influenced by sinister motives. If we could have a wise, impartial criticism of all public buildings which would really instruct, instead of the always ignorant and invariably fulsome comments of newspaper reporters, it would be a forward step; if the people whose money is spent for unworthy buildings could be taught to discriminate between the good and the bad, and made to understand that an architectural monstrosity, or, what is perhaps worse, an architectural platitude, is a crime, we should be still farther on the road to architectural reform. For this and many more reforms we must wait until ignorance, vulgarity, and vice are consumed, and their ashes swept away, by the steady light and consuming fire of universal education.

THE MANUFACTURE OF STEAM.

By a Staff Writer.

IT is well known to our readers that, at the instance of the Boston Manufacturers' Mutual Fire Insurance Company (Edward Atkinson, president), many very thorough investigations of various subjects affecting the construction and operation of factories and workshops have been conducted, as a result of which great improvements and great changes have been made on many points of the utmost service to the engineers and their clients. Among these may be named an almost complete revolution in mineral lubricating oils, and the establishment of lubrication as a department of established science on fixed rules; the sorting of safe and suitable steam-pipe coverings from those which were either dangerous or ineffective; the development of absolute rules for the lay-out of service pipes for fire purposes and for exercising a clear and suitable discrimination in the choice among the many varieties of fabric hose; improvements in fire pumps; and many other points.

A recent investigation of the use of suitable materials as fire retardents upon extensive wooden surfaces may be referred to, the report of which has lately been distributed. Within the next two months, as we are informed, reports of exhaustive experiments on the latest types of steam pipe coverings, boiler laggings, and the like, may be distributed, and also one on a very recent discovery, as it may be called, of the relative light and heat transmitted and diffused by the use of ribbed glass in place of plain glass in glazing, which may lead to an almost complete revolution in the glazing of factory and workshop windows, and which will have a very important bearing on the windows of school-houses, college buildings, libraries, and art galleries. All these have a direct and positive connection with the removal of dangers from fire; the last named may make it possible to entirely abandon the use of hazardous window shades in textile factories.

Mr. Atkinson considers it expedient to attempt to bring the manufacture of steam under simpler rules than those now open to engineers or to the owners of steam plants. As this does not come directly within the function of the underwriters, a circular was lately addressed to steam users, suggesting a contribution to a Steam Users' Association (corresponding to one which has existed for more than 40 years in England regarding which Mr. Atkinson obtained information after he had undertaken the work) for the purpose of making an attempt to reduce the whole subject to terms of easier comprehension than those now in use. The rules to be established were thus set forth in Mr. Atkinson's original circular proposing the investigation, *viz.* :

First—For preparing the ground for a boiler plant so as to avoid wasting heat in baking the ground beneath?

Second—For the kind of brick and other materials (aside from a few fire bricks) which may be used in the main part of the boiler setting?

Third—For the selection of a boiler?

Fourth—What kind of lagging to use to prevent radiation of heat from boilers?

Fifth—For the prevention of smoke through the complete combustion of the fuel, or upon any other point relating to this subject?

Sixth—For the construction of the chimney, its height and section?

The circular went on to say:

> The writer has endeavored to get systematic information on these points by a circular carefully prepared by experts and sent out. The replies were few in number, many of them incomplete, and nearly all of them at variance each with the other.
>
> In order to remedy this fault in our practice, the following suggestion is submitted: The undersigned, advised by a committee of the directors of the Boston Manufacturers' Mutual Fire Insurance Co., will select two competent men, well-trained, and perhaps of some experience in the practice of steam engineering, who shall not have been committed to any special type of boiler or to any existing method of manufacturing steam. These two men, with such assistance as the subscriptions may warrant if this plan is accepted, will be assigned to the duty of developing rules for the manufacture of steam in the safest and best manner. One will be assigned to duty in Great Britain, the other in New England and the Middle States. The co-operation of large steam users who are not insured by us will be asked. The plan for this undertaking will be prepared under the advice and with the aid of our present corps of engineers and inspectors, with such outside assistance as they may secure. The undertaking may occupy twelve months. The results will be put in type, and will be distributed among the subscribers to this investigation. Such documents may be copyrighted or may be made public, at the discretion of the committee under whose charge the work will be done.
>
> This investigation will not be undertaken unless the amount subscribed shall be deemed sufficient for effective work by the committee in charge. A secretary will be employed to keep the books and records. The specific records of the practice in each mill yard which may be disclosed will be strictly confidential. If results are compiled, no names will be given, but each establishment will be designated by a number, that number being disclosed only to the representative of that establishment.

We learn that a sufficient number of establishments and boilers have combined to make a beginning, and that the work is already under way. The general supervision will, of course, remain with Mr. Atkinson, but, as he does not claim to be an expert, the charge and direction of the investigation will be under Professor Peter Schwamb, of the Massachusetts Institute of Technology. Mr. Robert Sever Hale has been chosen to conduct a part of the investigation, and, when the subject has been a little more developed, another expert will be selected,—one of the two to be sent abroad for the study of foreign steam plants. Mr. George Atkinson, late treasurer of the Massachusetts Cotton Mills, acts as the secretary of this undertaking, which it is the present intention to continue for a year. If, however, the result of the work of the first few months should warrant it, a permanent organization may be made for the purpose of testing all new devices and bringing order into a subject which is now in a state of considerable confusion.

We are informed that the promoters of this enterprise do not solicit, and have not solicited, anyone to contribute. The opportunity is simply offered to any steam users, engineeers, or others to become members of the association on the contribution of $3.00 per boiler, which will entitle them to all the reports and results that may be made from time to time at whatever they are worth. That opportunity, as we are informed, is still open, and will continue to be open during the next few months, unless experience proves that the work can be better done in some other way, or that the funds will not suffice. On the latter point little doubt need be felt. Mr. Atkinson considers the fund now in his hands, or very certain to be placed in his hands if he needs any more, ample and sufficient for the work he is contemplating.

Postscript. As we go to press Mr. Atkinson informs us that "Progress Report, No. 1" is now in press, and will be ready for distribution to subscribers within a few days. It will give specific information as to the progress that has been made in the work of investigating the following subjects: Loss of heat into the ground; air leakage through settings; smoke prevention; and the choice of boilers and settings. In regard to the last point, the report will say: "It is well known that most of the boiler tests appearing in trade circulars are unreliable. We are pleased to report that many reliable tests, made at technical schools and by well-known engineers, have been placed at our disposal. The work of bringing them to a common standard and tabulating the results is now well under way." Copies of this first report will of course be supplied to those who now desire to become subscribers.

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE ENTIRE RANGE OF AMERICAN AND ENGLISH ENGINEERING LITERATURE.

INTRODUCTORY

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance ; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States, Great Britain and the British Colonies; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

We hold ourselves ready to supply—usually by return mail—the full text of every article reviewed or indexed, and our charge in each case is regulated closely by the cost of a single copy of the journal from which the article is taken.

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The entire Review is conveniently classified into the recognized divisions of applied science—everything pertaining to "Architecture and Building" appearing under that heading, while "Civil Engineering" is given under that title, and so on alphabetically throughout. Serial publications are usually indexed only on the appearance of the first installment, and this the original notice may be found by consulting previous issues. The titles and addresses of the majority of the journals reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated.; W=Words; Anon=Anonymous.

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Am. Chemical Journal. *b-m.* $4. Baltimore.
Am. Engineer and Railroad Journal. *b-w.* $3. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4 Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Archæologist, The. *m.* $1 Columbus, O.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $6. New York.
Arena, The *m.*, $5. Boston.
Australian Mining Standard. *w.* 30*s.* Sydney.
Banker's Magazine. *m.* 18*s.* London.
Bankers Magazine of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6*s.* London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick. *m.* $1. Chicago.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Geographical Soc. *q.* $5. New York.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $1.50. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Contemporary Review. *m.* $4.50. London.
Cosmopolitan, The *m.* $1.20. New York.
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Electric Power. *m.* $2 New York.
Electric Railway Gazette. *w.* $3. New York.
Electrical Age. *w.* $3. New York.
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York

Electrical Engineering. *m.* $1. Chicago.
Electrical Industries. *m.* $1. Chicago.
Electrical Journal. San Fancisco.
Electrical Plant. *m.* 6*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Engineer, The. *s-m.* $2.50. New York.
Engineer, The. *w.* 36*s.* London.
Engineer & Contractor. *w.* $1. San Francisco.
Engineering. *w.* 36*s.* London.
Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fairplay. *w.* 32*s.* 6*d.* London.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World, The. *w.* 13*s.* London.
Geological Magazine, The. *m.* 18s. London.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Industry. *m.* $2. San Francisco.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
Iron & Steel Trades' Journal. *w.* 25*s.* London
Iron Industries Gazette. *m.* $1.50. Buffalo.
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
our. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London
Journal of the Society of Arts. *w.* London.
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Lord's Magazine *m.* $1. Boston.
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Manufacturer and Builder. *m.* $1.50. New York.
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Marine Engineer. *m.* 7*s.* 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
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Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, New York.
Social Economist. *m.* $2, New York.
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Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
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Trans. Am. Ins. Electrical Eng. *m.* $5. N Y.
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Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.

ARCHITECTURE & BUILDING

Index to Architectural Illustrations.

UNDER this heading a portion of the space in the ENGINEERING MAGAZINE will, each month, be devoted to cataloguing the more important illustrations that appear in the architectural press. The number of professional publications is now so large that an index to this essential feature of architectural journalism is a necessity to the busy architect. The classified index, the first portion of which is published in this number of the MAGAZINE, will enable the architect to tell at a glance if any recent publication contains an illustration of a subject interesting to him.

In addition to preparing a monthly list of illustrations, some of the more important of them will be singled out for comment and review, so that the MAGAZINE will hereafter present an absolutely comprehensive survey of architectural work and literature. This field is unoccupied in architectural journalism, and, it is believed, will materially add to the value of the MAGAZINE.

The illustrations indexed will include only those published in the plates of architectural journals; minor illustrations in text, and the photo-engravings and other illustrations of the general magazines, being omitted altogether, as without the scope of this work.

The Twenty Ninth Annual Convention of the American Institute of Architects.

THE proceedings of the Institute of Architects, which met at St. Louis this year, are summarized in the *American Architect* (Oct. 26), and fully reported in *Architecture and Building* (Oct. 19 and 26). The papers read were strictly technical, including "Coöperation *vs.* Competition," by Normand S. Patton, of Chicago; "Suggestions by Which a Greater Influence may be Exercised by the Institute among the Architects of the Southwest," by James B. Cook, of Memphis; "Prevention of Staining of Plastering on Damp Walls and Fire-proofed Surfaces," by Louis De Coppet Berg; and "Woods of Washington," by C. W. Saunders. Several other papers were omitted, owing to the absence of their authors. In addition one evening session was given up to a eulogy of the late Richard M. Hunt by Henry Van Brunt.

In his introductory address President Daniel H. Burnham referred once more to the operations of the government architectural office in the treasury department, but the most notable part of his address was the suggestion for a permanent home for the Institute, including the gathering of a library. He urged that the wealthy friends of the Institute should be called upon to provide this house, which unquestionably would add to its prestige, and give it a value in the public eye which it cannot have while it has no permanent quarters.

That the idea is a good one every friend of the Institute will admit. A very considerable source of strength to the Royal Institute of British Architects in London is its permanent home and its staff of permanent officials. But it by no means appears why the funds for this purpose should come from outside the Institute. It has long been the custom among certain classes of public organizations to depend upon others for assistance; the help rendered by the theatrical profession to many charities is a case in point. But are the architects of this country in such financial straits that they cannot themselves build a home for their own great organization? It would seem much more reasonable, business-like, and straightforward to erect a large office building, as the *American Architect* half-jokingly suggests, which would be a source of revenue to the Institute, and the funds for which could be secured in a business-like manner, without appeals to charity.

Nor would the funds to support such a

building be small. The Royal Institute has a handsome income from the fees of its members; it publishes a handsome journal; it has a large library; and its running expenses are not slight. The library is large, but it is chiefly made up of gifts and donations from members, no more than £100 being expended yearly for the purchase of books. It is no wonder, therefore, that the splendidly endowed Avery Library in Columbia College should be larger and richer than the library in London. It would be a pity for the architects of this country to undertake to duplicate the collection that the liberality of Mr. Avery has supplied for their benefit in New York. Whatever work the Institute may undertake in connection with a library should be done in conjunction with the Avery collection, which, in New York, is as accessible to the architects of the United States as any other collection would be in any place.

Another important matter brought before the meeting was that of membership. This comes up annually, but this year an urgent necessity for modification in the conditions of membership was freely recognized. The matter was frankly referred to by Secretary Stone in his report, in which he spoke of the systems of examination adopted by the Royal Institute of Architects, which thus gives to its members a degree of architectural standing in the profession without the help of a license law.

This is unquestionably the most important matter the Institute will have to consider until it is settled. True, the profession at large is in favor of a license law for each State, or, rather, for a uniform license law which would lead to a uniform practice of architecture. But much of this support for license comes from a misunderstanding of its nature and of its application to professions and occupations already licensed. The profession has the means within itself to accomplish more for the betterment of architects and of architecture than fifty license laws. The admission of this fact by the Institute is a circumstance of no small importance, and it should have due weight.

Convention Halls.

Mr. Dankmar Adler contributes to the September and October numbers of the *Inland Architect* an interesting paper on the building of convention halls, full of good sense and valuable suggestions. Mr. Adler has fitted up no fewer than four great convention halls,—for the Republicans in 1884, 1888, and 1892, and for the Democrats in 1884,—and he speaks, therefore, with authority.

While it ought to be an easy matter to house a national convention of nine hundred delegates, forty or fifty reporters and correspondents, and as many pages and telegraph operators, the American people insist on gathering in large numbers at these times, and greatly complicating the problem of arrangement and disposition. The first step is to provide seats for the delegates, who require ample space, owing to the sometimes protracted length of the sessions. Ample passage-room must also be secured in this part. The platform for the chairman and secretary must be high enough to enable these officials to see from it the face of every delegate. About 7½ ft. was found a good allowance to each delegate, and 5½ to each alternate. Utmost convenience is necessary for the telegraph operators and reporters, and even the presence of distinguished guests entails a burden upon the architect.

The greatest difficulty, however, is with the audience. Every member wants to see every delegate and all the officers, and hear every word. In banking up seats and laying out isacoustic curves and determining sight lines, it must not be forgotten that the delegates occupy a space of from 6000 to 7000 sq. ft., and that a speaker in whom the entire audience is interested should be able to stand anywhere within that area and face in almost any direction.

The convention proper thus comes in the center of the hall, the speakers being arranged as nearly as can be on the lines of the Scott-Russell isacoustic curve. A low ceiling or sounding board over the delegates would be desirable, but it is impracticable on account of the audience, which wishes to see everything. There should be no standing room, the ushers, pages, and others necessarily employed upon the floor of the convention affording a standing audience of considerable extent. All seats should be legibly marked, and the division into sections carefully distinguished. Aisles should be covered with matting, and the space under the hall entirely closed to outsiders. Stairs must be wide, an allowance of 1½ to 2 ft. for every 100 persons using each flight being reasonable. Stairs wider than 5 ft. should have intermediate rails. They should be strong, not too steep, with broad landings and no winders.

The architect's supervision of this work is of the most exacting kind, and frequently compels personal examination of every part of the hall after each meeting. Ventilation and heating are necessarily of the crudest sort, but the preparation of the working drawings entails a vast quantity of labor, which is necessarily minute. It is a work that brings little thanks to the architect, yet these convention halls are a not unimportant item in the many problems to be met and solved in architectural practise.

The Use of Cast-iron Columns in Building.

THE use of cast-iron columns in building is deprecated editorially by *The Engineering Record*, in a recent article calling attention to the fact that the coroner's inquest "brought forth no demonstrative evidence to the effect that the fractured iron columns were not the cause of the much-discussed fall of the Ireland building in New York city." This evidence indicates a strong probability that defective foundations were the immediate cause of the accident; but, in our contemporary's opinion, the evidence was not conclusive on that point. "The insidious character of cast-iron in columns for building has caused such columns to be discarded from the practice of civil engineering in bridge building, their liability to crack and fail rendering them unfit for this class of work. If not fit for bridge-work, how can such columns be reliable for buildings?" The *Engineering News* thinks they should be discarded from architectural practice. On this point it says:

"It is true that all portions of all cast-iron columns are not positively bad, but engineering experience has many times demonstrated that few or no cast iron columns can be relied upon to be positively good. High internal stresses due to inevitably irregular cooling, gas and air holes invariably present, dangerous irregularities in thickness, and extreme variations in quality of material in the same piece, lead to cracks and failures, which, both before and after loading, are by no means infrequent. The cracked, patched, and reënforced base castings along some portions of the elevated roads of New York city indicate with sufficient clearness just what kind of metal cast-iron is. If the cast-iron columns in use in the buildings of any large city were equally exposed to view, they would illustrate an interesting chapter in building construction, in which, incidentally, tenpenny-nail shimming would add materially to the total interest of the matter. There is little doubt that so much of cast-iron column practice as is now left is wholly due to the concealment of these members in the completed building. Were they as open to inspection as bridge members, they would be relegated to 'innocuous desuetude' in short order. No brittle material which goes all to pieces without warning when it fails, as Mr. Brown admits cast iron does, is any more than indifferently qualified at best for structural purposes; and, when such admirable materials as wrought iron and steel can be employed at practically no additional cost under proper design, cast-iron columns have absolutely no *raison d'être*.

Faulty Fire Escapes.

AN examination of fire escapes made by Owen B. Maginnis leads him to express the opinion in *Architecture and Building* (Aug. 10) that these appliances on flats, tenements, and factories are in the majority of cases entirely useless. He particularly condemns that kind of so-called fire escape which consists of platforms, one at each story, each having an opening in the center or side connected with an iron ladder to the next one below; yet this is one of the most commonly adopted devices,

Illustrations of the Month.

THE difference between architectural design in New York and Chicago has seldom been more strikingly shown than in the design for the new department store for the Siegel-Cooper Co. on Sixth avenue (*Architecture and Building*, Oct. 5, 1895). The Chicago building occupied by this firm is a plain, simple, straightforward structure. It is rectangular, without ornament of any sort,—nothing save the vertical and horizontal lines of granite with which the building is built. It is satisfactory in its severity, and because no "architecture" was attempted. It might have been hoped that, when this firm decided on opening a New York store, they would employ a Chicago architect and give New York an example of the fine commercial architecture of the western metropolis. Nothing of the sort was done. A New York architect was selected, and a design in the most approved New York style was chosen. That is to say, a building of seven stories, one of which is hidden behind the balustrade on the roof, with ornamental entrances, varied treatment of the floors, pilasters, panels, and a tower in the center of one front,—a design that could not have been thought of outside New York, and which is full of the vulgar display that characterizes most of the dry goods architecture of the metropolis.

After the fussiness of this design, it is refreshing to review once more the fine conceptions worked out in the Wainwright and Union Trust Buildings in St. Louis, photographs of which are published in the *American Architect* (Oct. 12). Both these buildings are entirely satisfactory in being ornamental and artistic. What ornament is used is employed naturally and with good effect. The silhouette is fine, the detail good. There is nothing wanting to secure the greatest of artistic successes in commercial design.

That commercial design in the west does not often touch the high standard created by Messrs. Adler and Sullivan in their St. Louis buildings is borne in upon one by the study of some new designs published in the *Inland Architect*. An office building for T. A. Davies by Jenney and Mundie is a twelve-story building, sufficiently plain in design, with a large bow window on each side from the fourth to the eleventh story. The design shows that difficulty in getting started which is apparent in the work of most architects; that is to say, a basement of two stories and an entresol before the superstructure, or main portion of the design, is entered upon. The effect of the upper part, and indeed the whole design, is injured by the large blocked frames which enclose the windows, and by the heavy lines carried around the bows below and above the windows. It needs more than a second glance to satisfy one that this is not a horizontal design, cut up into twelve layers.

The Century Building in St. Louis is an unhappy example of cutting up a ten-story structure by horizontal lines. Situated on a corner site, it has a long and a short side, both of similar design. A basement of two stories is surmounted by the inevitable entresol. The superstructure is only four stories high; the windows are arranged in bays with circular heads. Then come the frieze story and a broad cornice. Logically the building comes to an end at this point, but two additional stories are added above the cornice, with another cornice above, and a solid balustrade, surmounted on the corners by standards carrying lights. There is little detail shown in the drawing. The building for the Bell estate, Cincinnati, illustrated in the same paper, is an extraordinarily fussy design, with plate-glass walls below, and bow windows, windows within bays and without, balconies, cornices, horizontal bands, a section with pilasters, an attic story, and a balustrade with obelisks.

ONE of the many striking facts connected with the advancement of architecture in America is that it is almost wholly necessary to depend on the public spirit of our private citizens for really notable contributions to ornamental structures in our great cities. This is true, also, of the country; but in rural districts the traveller, in his enjoyment of the natural scenery, may well overlook the absence of ornamental houses. The cities, on the other hand, present the dreariest appearance possible, if there are no handsome houses or imposing business buildings, both of which classes of buildings are due entirely to private enterprise.

The rich men of New York are gradually building for themselves more or less sumptuous residences, some few of which must already be counted among the most notable structures of the city. Among the most recent of these is the residence of Mr. C. P. Huntington, at Fifth avenue and Fifty-Seventh street, some fine photographs of which are published in *Architecture and Building* (Oct. 5 and 12). Mr. Huntington is one of the very rich men of New York, and it might readily have been expected that he would have built a rich and splendid mansion. His house is big enough, and costly enough, and its situation is all that could be desired, but as a design it is totally uninteresting, and, far from being an ornament to Fifth avenue, is quite the reverse. It is somewhat irregular in plan, yet entirely devoid of picturesqueness. It is three stories high, with a moderately-sloping roof, whose dormers are partly hidden by the balustrade at the top. The walls are of rough stone, that of the basement being slightly heavier than the upper portion. The windows here are likewise plainer, with inner frames, while in the upper stories they are enclosed within columns and entablatures, with pointed pediments on the second floor. Of ornament there is scarcely anything, save a series of grotesque masks in the first story windows,—most unpleasant things to look at, though possibly having an economic value in frightening away burglars and other improper persons.

As a whole, this is one of the most disappointing edifices built of late. What relatively small amount of detail is included in the fronts is cold and hard, without even that air of correctness which sometimes redeems unfeeling ornament from utter failure. The house is neither stately or magnificent, though large enough to exhibit both these qualities. That it is satisfactory to its owner is to be presumed, because he has had it built, but it is a most conspicuous failure as an architectural adornment to New York.

THE competition for the West Ham Technical Institute, which has recently been decided in London, has attracted a good deal of attention in England, and has been copiously illustrated in the English architectural press (*Builder*, Oct. 5; *Building News*, Oct. 4; *Architect*, Oct. 11, 18, 26). It is a characteristic English Institute, including a lecture hall, library, technical schools, meeting and recreation rooms, and a variety of minor apartments grouped under a single roof, the programme being quite unlike anything the American architect has to consider in ordinary practice. The estimated cost of the projected building is $200,000.

Seventy-three designs were presented in the competition, of which we need concern ourselves only with the successful one. In plan this is simple and admirable, with the lecture hall, opening upon the main front, in the center, the library and allied departments on one side, and the school and miscellaneous rooms on the other, and extending around on the fourth side. Much ingenuity is displayed in the plan, which necessarily included considerable dissimilarity and irregularity in the disposition of the various apartments of this somewhat mixed interior.

The dissimilarity extends to the designs of the façades, which are drawn in an Elizabethan type of classic of decided English character, with a good deal of freedom in the treatment, though by no means free from faults which further study will eradicate. On one front is a porch with a segmental coping supported on stooping caryatides, which form the entrance to the lecture hall. On each side are segmental topped windows with heavily-blocked frames and large keys cutting into a broad foliated frieze. On this stand applied columns carrying the main cornice, with a regular series of windows in the upper part of the wall, separated by small columns. Another front has for its main feature a series of decorated semicircular pediments, which are also repeated on the first front. The upper story here is again more highly decorated than the lower. The design is not of the first importance, but it is a straightforward attempt to produce a structure useful and ornamental, and still keep within the amount set apart for the building. There is no shoddy classicism in this conception, no importation from foreign lands; it is a thoroughly British building, designed for British purposes.

THE *Architectural Review* (No. 8, Vol. 3) publishes the design which won for its author the McKim Roman Scholarship and the Columbia College Fellowship in Architecture. The problem was the relatively simple one of a bank for savings, characterized by a practicability and usefulness which does not always distinguish the problems set for our young architectural students. That this design was the best of the series submitted in the competition need not be questioned; the standing of the judges who made the award does not leave that question open to debate. But whether it is useful for young men to design exercises in the French type of classic architecture as a foundation for their future work is a much more serious matter.

Many banks for savings throughout the country have, within the last few years, erected large and costly buildings for themselves, which are more or less ornamental to the districts in which they are situated. But the very richest of them has not attempted so magnificent a palace as this young college student has figured to himself. It is true, the building was not intended to be built, and a certain license is allowable in a mere design on paper which would not be tolerated in a design that was to be executed. Yet the fact of this allowance, the ample space given to the site, the absence of a cost limit, and the general splendor with which the conception has been carried out, at once remove it from the realities of architecture, and place it among those interesting fancies with which the young men in Paris are taught to design. Admitting that these elements of unreality are admissible in a case like the present, we have here a design of considerable success. The use of two series of Ionic columns of different heights has not been entirely successful, but, as a whole, it is quiet and subdued building.

When its author gets to designing real banks for savings, he will unquestionably, if he has a proper regard for the convenience of the patrons of his building, provide a direct means of access from the street. An ornamental wall, with a high pedestal surmounted by a statue, with a lion at either end, forms a sufficiently satisfactory frontage according to French ideas, but there is an extended popular prejudice in America in favor of a direct stair from the street to the main entrance.

Index to Illustrations.

ART GALLERIES. The Olney Art Gallery, Cleveland, O., by Coburn, Barnum & Denes, In. Archt., Oct.

CHURCHES. Proposed west front, Manchester Cathedral, by B. Champneys, Builder, Oct. 12.—Church of the Most Holy Redeemer, Chelsea (interior) by E. Goldie, ibid.—Church of St. James, Spanish Place, London (interiors) by Goldie, Child & Goldie, ibid.—A Labor Church (plans and elevations), by G. L. Morris, ibid, Oct. 12.—Proposed P. E. Church, Eckington, Washington, D. C. (interior), by W. & G. Audsley, Archt. & Build., Oct. 26.—Riverside Baptist Church, New York, by W. E. Bloodgood, ibid, Oct. 19.—Private Chapel, Pyrgo Park, alterations by P. H. Roberts, Amer. Arch., Oct. 26.

CLUB HOUSES. Baltimore Club House, Baltimore, Md. (plans and views), by J. A. & W. T. Wilson, Amer. Archt., Oct. 19.—Club House of the Delta Kappa Epsilon Society, Middletown, Conn. (details), Archt. & Build., Oct. 5 and 12.

COMMERCIAL BUILDINGS. Union Trust Co. Building, St. Louis, Mo., by Adler & Sullivan and C. K. Ramsay, Amer. Arch., Oct. 12.—Wainwright Building, St. Louis, by the same, ibid.—McDonald & Taylor Building, Fort Wayne, Ind., by Wing & Mahurin, ibid, Oct. 5.—Design for Halifax & Huddersfield Bank, Halifax, by Tarbolton & Tugwell, ibid, Oct. 26.—Departmental Store Building for Siegel, Cooper & Co., New York, by DeLemes & Cordes, Archt. & Build., Oct. 5.—Chapin Building, Buffalo, N. Y. (elevation), by E. A. Kent, Brickbuilder, Oct.—Business Premises, by F. J. Cooper, Builder, Oct. 26.

HOUSES. For C. P. Huntington, New York, by G. B. Post, Archt. & Build., Oct. 5 & 12.—Study for F. G. Russell, Bronxville, N. Y., by Jardine, Kent & Jardine, ibid, Oct. 19.—For F. E. Lay, Westfield, Mass., by E. A. Ellsworth, ibid, Oct. 26.—For Dr. W. S. Bryant, Boston, Mass. (staircase-hall), by W. Y. Peters, Amer. Archt., Oct. 5.—For E. L. Sheppard, Wissahickon Heights, Philadelphia, Pa., by Hazlehurst & Huckel, ibid, Oct. 12.—For J. E. Devlin (mantel), by Wheelwright & Haven, ibid, Oct. 19.—For J. C. Hoagland (exteriors and interiors), Seabright, N. J., by Shepley, Rutan & Coolidge, ibid, Oct. 26.—For Hon. A. Wood, Woodmont, Pa. (working drawings and details), Archt. Rev., No. 8, Vol. 3.—House in Detroit, Inland Archt., Oct.—For C. H. Taylor, Chicago, by Treat & Foltz, ibid.—Competition for City House, Brickbuilder, Oct.—"St. Keverne," Harrow-on-the-Hill, by A. Mitchell, Archt., Oct. 25.—Gosford House, Staircase Hall, by W. Young, Builder, Oct. 26.—"Teith View," near Doune, N. B., by Niven & Wiggleworth, ibid.—Small Town House, by F. J. Cooper, ibid.

LIBRARIES. Public Library, Fall River, Mass: accepted design by Cram, Wentworth & Goodhue; competitive designs by A. M. Marble; by Abbott & Thompkins; by C. H. Farnham (views, elevations, plans), Amer. Archt., Oct. 26.—West Ham Technical Institute and Public Library; accepted design by Gibson & Russell, Builder, Oct. 5; competitive designs by Clark & Hutchinson; by T. Davison, Archt., 11 and 18 (perspectives, elevations, plans, details).

PARIS EXHIBITION. Bird's eye view of scheme and plan, Amer. Archt., Oct. 19.

PUBLIC BUILDINGS. Design for Minnesota State-house submitted in first competition, by J. A. Schweinfurth, Amer. Archt., Oct. 19.—Imperial Institute, London; Canadian Conference Room, Australian Conference Room (interiors), by T. E Collcutt, ibid, Oct. 19.—Fourteenth Regiment Armory, Brooklyn, N. Y., by W. A. Mundell, Archt. & Build., Oct. 26.—Hospital by J. B. Lord, ibid, Oct. 12.—State Normal School, West Superior, Wis., by H. W. Jones, ibid, Oct. 26.—Police Station, Stoke-upon-Trent, by C. Lynam, Archt., Oct. 4.—James Street School, Auburn, N. Y., by J. A. Schweinfurth, Inland Archt., Oct.

HISTORICAL AND MISCELLANEOUS. City Hall, New York; measured drawings of elevation and section by L. F. Pilcher and C. H. Lum, Archt. & Build., Oct. 19.—Palazzo Vecchio, Florence; Envoi of the Rotch Travelling Scholarship, by W. H. Kilham (India ink elevation) Archt. Rev., No. 8, vol. 3.—Winning design for the McKim Roman Scholarship and the Columbia College Fellowship in Architecture, by J. R. Pope (elevation and plan), ibid.—Wolfgang's Kirche, Rothenburg, from water color by R. P. Spiers, Builder, Oct. 19.—Measured drawing of arcade in court of house on Via Arche, Acaligere, Verona, Brickbuilder, Oct.—Romsey Abbey, by C. E. Mallows and R. P. Spiers (with plan). Builder, Oct. 5.—Abbey of Jumieges after Cotman, Archt., Oct. 4, 11, 18, 25.—St. Mary's Church, Brading, Isle of Wight, by A. B. Bibb, Amer. Archt., Oct. 5.—Panfolfini Palace, Florence, by W. H. Orchard, ibid, Oct. 19. The Sun Dial, Walton House, by A. W. Brewill & B. E. Bailey, Builder, Oct. 19.—Crematorium and Chapel, by Tarbolton & Tugwells, Archt., Oct. 25.

HOTELS.—Hotel Cecil, Victoria Embankment, London (façade, plans, interior), by Perry & Reed, Builder, Oct. 19.—Hotel St. Nicholas, St. Louis, Mo., by Adler & Sullivan & C. K. Ramsey, Amer. Archt., Oct. 5.—Spencer House, Niagara Falls, N. Y. (view and pla by E. A. Kent, Archt. & Build., Oct. 12.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Architecture and Building in the American, English and British Colonial Technical Journals—See Introductory.

*1893. Schools and School-House Architecture. Ill. E. C. Gardner (Detailing the requisites to be observed in the location and construction of school-houses). Eng Mag–Dec. 3400 w.

†1934. Tenement-Houses and Dwellings for Workingmen in Glasgow. Allen B. Morse (Report to State Department. Treats of laws and municipal ordinances regulating construction and use; building rules and regulations; the houses and their inhabitants; corporation tenement houses). Sanitarian–Oct. 5500 w.

*1945. Bricks, Tiles and Terra-Cotta in America (Review of an extensive work by Charles Thomas Davis, with extracts. The reviewer thinks it a valuable work for all who employ clay as a material). Arch, Lond-Oct. 4. 3500 w.

*1951. The Churches of Norwich, Eng. Ill. (A brief account of the ancient churches of the place, which have escaped modernization and have only been sufficiently restored to keep them in a substantial condition). Builder–Oct. 5. 3500 w.

†1992. The All-Around Architect. C. H. Blackall (A consideration of the enormous extension of the field which a successful architect is required to cover, and advising young men to fit themselves to act both as architectural adviser and master builder). In Arch–Oct. 4400 w.

2004.—75 cts. Architecture from the Architect's Point of View. Ill. Albert L. Brockway (Differences between the public conception of architecture and that of the architect. The architect's point of view explained). Arch Rev–Vol. III. No. 8. 4500 w.

2014. The New York Clearing House (Describes the purpose and working of this financial institution, and illustrates and describes a new building for its accommodation recently designed in the Italian renaissance style, by R. W. Gibson). Sci Am Sup-Oct. 19. 2700 w.

2038. Recent Chicago Tall Buildings. Ill. (A very thorough review of the engineering and architectural methods used in tall building construction). Eng News-Oct. 17. 2200 w.

*2047. A Twentieth Century Palace of Commerce. Ill. (A detailed description of the Emporium of San Francisco, suggesting that it would be interesting to place in the center of this "greatest building of its kind on earth," a museum showing by models or object lessons the development of commerce from its first dawning to the present time. An outline of commercial progress and a description of the construction of the building). Overland Monthly-Oct. 5400 w.

*2061. On the Bearing and Resisting Strength of Structures and That of Their Component Parts and Materials. Charles Baillairge (Read before the Quebec Asso of Arch. Discussion of the subject with tabulated statements of the sectional area in square inches, of steel built columns to support the weights, the thickness of their component plates, the weight in tons to be supported and the corresponding prices at a uniform rate of five cents to the pound, &c., &c.) Can Arch-Oct. 3000 w.

*2062. Decoration of Public Buildings. C. L. Eastlake (Discusses the external conditions of works of art, dimensions, situation, light and means of representation, position, magnitude, form, etc.) Arch, Lond-Oct. 11. Serial. 1st part. 5800 w.

*2063. Speculations on Ancient Vaulting. (Descriptive of ancient methods, with quotations of accounts from ancient writers). Arch, Lond-Oct. 12. 2800 w.

*2066. Short Forms of Agreements for Builders and Contractors. W. H. Stacpoole (It is proposed to give some short forms of agreements which are likely to be of use to persons engaged in the building trade). Ill Car & Build-Oct. 11. Serial. 1st part. 1500 w.

2095. Foundations of the Fisher Building. E. C. Shankland (Explanatory of the theory upon which the unusually short piles were used, with sections and plan. The theory is that there should be just enough cubic contents in the piles to squeeze the water out of the soil). Eng Rec-Oct. 19. 250 w.

2098. Prevention of Staining of Plastering on Damp Walls and Fireproofed Surfaces. Louis de Coppet Berg (Read at the convention of the Am. Inst. of Arch. at St. Louis. The author believes a permanent and successful remedy has been found). Am Arch-Oct. 19. 3200 w.

*2100. A Question of Church Style (Editorial discussion as to whether there is such a style, suggested by two churches, differing in character, recently erected in England for Roman Catholic worship). Builder-Oct. 12. 1300 w.

†2196. Maps, Plans, and Views of the City of Rome. R. Lanciana (With Especial Reference to a 16th Century Drawing of the city in the Burlington-Devonshire Collection). Jour Roy Inst of Brit Arch-Sept. 3500 w.

†2197. The Municipal Buildings of Edinburgh. J. M. Brydon (An interesting review of a book by Robert Miller, which is a sketch of the history of these buildings for 700 years). Jour Roy Inst of Brit Arch-Sept. 4000 w.

†2198. Architecture at the Exhibitions of the Royal Academy. R. F. Chisholm (A criticism of the system in vogue, and a discussion of the subject, with suggestions tending to correct the present evils). Jour Roy Inst of Brit Arch-Sept. 2800 w.

†2199. Káfiristán. Sir George Robertson's report (Origin and physical characteristics; villages and houses; the one-room house; houses of the better class; houses of the Presun Káfirs; a Káfir tower; the dancing place and gromma or church). Jour Roy Inst of Brit Arch-Sept. 4200 w.

*2200. The Hotel Cecil, London. Ill. (Description of the building and site). Builder-Oct. 19. 3000 w.

2206. Suggestions by Which a Greater Influence May Be Exercised by the American Institute of Architects Among the Architects of the Southwest, at the Same Time, the Elevation of the Profession before the Public. James B. Cook (A paper read at the Convention in St. Louis). Am Arch-Oct. 26. 2800 w.

*2216. Treatment of Outside Hard-Wood Finish. F. J. Thayer (Methods described). Ill Car & Build-Oct. 18. 1100 w.

*2217. Stencils and Stencilling. Ill. F. Parsons (An article written with the view of assisting the inexperienced). Ill Car & Build-Oct. 18. 2000 w.

*2218. Inlaid Work (Historical account). Ill Car & Build-Oct. 18. 1200 w.

2225. A Young Architect's Bicycle Trip in Europe. Francis H. Bent (Economic means of travel, and architectural study in the old world—Naples and Rome). Eng Rec-Oct. 26. 3500 w.

†2285. Mural Decoration in America. Ill. Royal Cortissoz (The author considers mural decoration as a half-sister of architecture. Work of artists of note considered, and a critical review of recent work given). Cent Mag-Nov. Serial. 1st part. 7000 w.

*2383. Bricks, Tiles, and Terra-Cotta (An editorial review of book by C. T. Davis). Builder-Oct. 26. 2000 w.

*2384. American Opinion on Architectural Education (A reprint of the report on education, drawn up by Mr. Van Brunt, as chairman of committee of the Am. Inst. of Archs., with some comments). Builder-Oct. 26. 3000 w.

2387. Richard Morris Hunt (A memorial address by Mr. Henry Van Brunt, delivered at the twenty-ninth Convention of the Am. Inst. of Arch. at St. Louis, Oct. 15-17, 1895). Am Arch-Nov. 2. 7800 w.

2388. Co operation versus Competition. Normand S. Patton (A paper read at the 29th Annual Convention of the Am. Inst. of Arch. suggesting a new motive for co-operation). Am Arch-Nov. 2. 3000 w.

2458. Tests of Long-Span Terra-Cotta Floor Arches. Ill. Gunvald Aus (The floor arches tested were in the new appraiser's warehouse in New York City. The floors are composed of 24-in. I beams supporting terra-cotta arches of 11 ft. 6 in., and 15 ft. 4 in. spans, the spans of the I beams bring generally 23 ft.). Eng News-Nov. 9. 900 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Tests of Paving Brick.

A LARGE number of cities in Ohio, ndiana, and Illinois have been paved with the vitrified brick made in that region; these States are particularly rich in hales of the Silurian, Devonian, and Carboniferous ages, and in impure fire-clays and Quaternary clays, though the latter are apt to lack uniformity and to be too easily fusible. *Paving and Municipal Engineering* (Nov.) abstracts from advance sheets from the annual report of the United States geological survey on the "Technology of the Clay Industry" as follows: "The heat required to vitrify a clay varies, and some of the fire-clays used cannot be said to vitrify. In the Ohio clays (Geol. Sur. O., VII, p. 138) it was found that the heat required to vitrify the clay or shale was about 1860 F. The fusibility seemed to be due partly to the alkaline earths and alkalies present. Iron did not seem to aid much in the fusion." The table given shows the vitrifying temperatures required for some Ohio clays.

TEMPERATURE OF PAVING BRICK KILNS IN DEGREES F.

Material.	Kiln at best heat	Kiln at high'st heat.
Fire clay..............	1862	1920
Shales	1800	1840

Three tests are usually applied to these brick,—absorption, abrasion, and crushing.

"From a large series of tests recently made by Mr. Ficks the following facts were developed:

"1. A brick which stands rattling well has ample crushing strength, and rarely chips under less than 5000 lbs. per sq. in., or crushes under less than 10,000 lbs. The crushing strength tends to vary with the resistance to abrasion, however, but more slowly and irregularly.

"2. The transverse strength also tends to vary with the resistance to abrasion, but more slowly and irregularly.

"3. The toughest brick usually absorb the least water, but exceptions occur."

Some valuable and interesting tests were recently made by the Ohio geological survey to determine the relative merits of fire-clays and shales for the manufacture of paving brick. Twenty-three varieties of shale brick, or bricks whose largest constituent is shale, were grouped together; fifteen varieties of fire-clay brick; four varieties composed of shale and fire-clay mixed in equal proportion; and the varieties made of Ohio river sedimentary clays.

RELATIVE RESULTS OF OHIO FIRE BRICK TESTS.

Kind of Clay	Abrasion.	Rattling.	Crushing.	
			Square inches	Cubic Inches.
Shales	1.17	17.61	7307	1764
Fine clay..	1.62	17.32	6876	1678
Mixture...	1.41	18.72	5788	1400
River clay.	1.36	19.02	4605	1176

The Port Royal Dry Dock.

THIS important work, carried on under the supervision of the bureau of yards and docks of the United States navy department, is now ready to be tested. The cost will be about $500,000, and it possesses some new features of interest to engineers. *The Engineering Record* (Oct. 5) gives a description, from which the following is abstracted.

"Its general dimensions are given in the following table, which also gives similar data relating to other timber dry docks in this country.

	Port Orchard.	Port Royal.	League Island.	Brooklyn.
Length on coping*.... ..	625′	476′	500′	500′
Length on floor...........	573′6″	420′	439′10″	439′10″
Width on coping.	130′1½″	126′	130′	130′
Width on floor	67′1½″	54′	50′	50′
Depth coping to m. h. w..	7′	7′5″	5′	5′
Depth coping to floor	39′3″	33′9″	32′8″	32′8″
Draft over sill, m. h. w...	30′	26′	25′6″	25½′

* From head to inner gate sill when there are two.

"These figures may not be absolutely correct, as they are taken from unofficial sources, but they are believed to represent approximately the relative sizes of the different docks.

"The primary element of the body is a transverse rib running along the floor, up the sides, and out on or just below the surface of the ground. Each rib is supported on piles, which are spaced in one direction, as shown in Fig. 1, and every 4 ft. in the other direction, parallel to the axis of the docks. Along the center of the dock there are nine piles, driven very close together, and cut off 14 in. below the tops of the remainder. These nine piles are capped with a 14×16-in. substringer 13 ft. long, and on it and the remaining piles rests the 14×16-in. main floor stringer. In addition, short intermediate bents of five piles each and a 13×14×16-in. cap are placed between the main ribs under the central portion of the dock, where most of the weight comes. Most of the timber in the dock, including piles, is long leaf yellow pine; the keel and bilge blocks are of oak. . . . The space between the back of the altars and the sheathing is filled with hot tar concrete, mixed in the proportion of 1 barrel of boiling tar to 1 cu. yd. of hot, dry sand and gravel. . . . The drainage floor rests directly on the bed of shell concrete, and is bolted to the floor stringers. The system of drainage provides for the discharge of all water in the dock into the pump well, but it does not relieve the great pressure which might come upon the altar sheathing, if the earth behind it were to become filled with water." To prevent this, in a measure, 5×10-in. sheet piling is driven around the outer edge of the dock, and 2 ft. of clay puddle rammed behind the altar stringers, while the floor is supported on a 3-ft. bed of concrete, composed of 1 part by measure of Portland cement, 2 parts of sand and gravel, and 5 parts of oyster shells. "The dock is emptied by two Southwark centrifugal pumps with 42-in. and 40-in. discharge openings. They are located in a pit with their center line below the mean high-water level, in order to keep the maximum suction lift down to about 21 ft. The contract capacity of the pumps is 70,000 gals. a minute. They are driven by a 24×24-in. vertical engine, with a fly-wheel 5 ft. 5 in. in diameter, directly connected with the pumps. The boiler plant consists of three horizontal return tubular boilers 16 ft. long and 72 in. in diameter, having 80 4-in. tubes. The steam pressure is about 80 lbs."

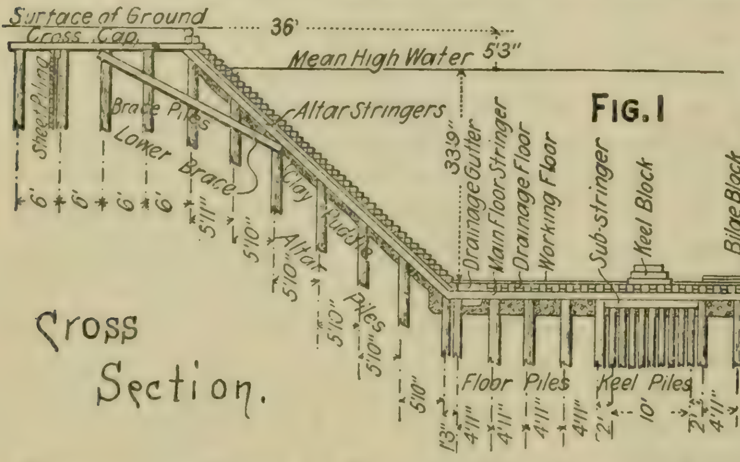


FIG. 1

Cross Section.

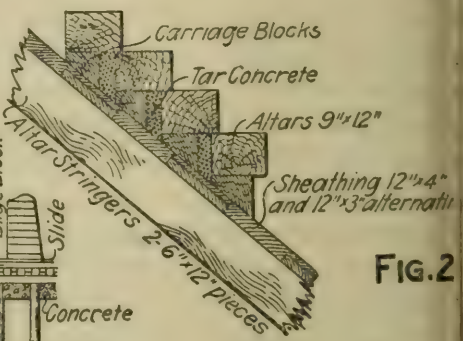

Carriage Blocks
Tar Concrete
Altars 9"×12"
Sheathing 12"×4" and 12"×3" alternati
Altar Stringers 2-6"×12" pieces

FIG. 2

Detail.

Heat Tests for Cement.

SPEAKING of the heat tests which cements are being subjected to to determine their time-resisting qualities, the *Engineering News* (Oct. 31) says: "Heat tests have shown much promise in this respect, although they have been but little adopted. They are, we believe, gaining more and more the attention of cement users, both in this country and abroad." M. Le Chatelier, in his report to the French commission, has taken the experiments of Prof. L. Tetmajer, of Zurich, as a basis for the following remarks: "In the course of time all hydraulic cements and limes employed in works of construction are disintegrated by the various influences of na ure. The longer a cement resists these ttacks, the better it is. It would seem nportant, therefore, to be able to ascer-ain by tests the degree of this resistance.

"The causes of disintegration are many, ut may be divided into two classes: (1) hose which act only under certain con-itions, as the action of sea water, frost, heat of the sun, etc.; and (2) those which ct under all conditions, as water and car-bonic acid. These latter are the less ener-gectic in action." In durability tests the cement is generally molded into good-sized pats, or cakes, with thin edges; this shape renders cracks, scaling, etc., more readily observable. The pats are subjected to test at the end of 24 hours. Comparative tests were made in cold water, in air, in kilns up to 120° C. in a gas flame up to red heat, and in water brought to boiling-point in 1½ hours and kept boiling for 6 hours, with the following results:

"*Portland Cements.*—Of 139 cements tested, two only showed signs of disintegration after 3 years in cold water. In the tests in air 18 altered completely, and 7 showed less marked disintegration. The boiling or coking test destroyed 17 cements completely and developed cracks in 11 more. All the cements disintegrating in air were destroyed by the boiling test, but, while the disintegration in air became evident only after a year, it was developed by boiling in 6 hours. A certain agreement appears to exist between the time necessary to develop disintegration in air and in boiling water. The cements which disintegrated in air in less than 6 months could not resist the boiling water more than 4 hours, and those that stood in air only a few days disintegrated in boiling water in less than 2 hours. The results obtained do not admit of any definite relations being deducted on this point. The kiln tests and red-heat tests give results identical with the boiling tests. In conclusion, it may be said that the results of the tests on Portland cement demonstrate that for such cements the boiling test is excellent. It gives in 6 hours the same results that a test of a year's duration in air does.

"*Slag Cements.*—The boiling tests did not give such positive results as in the case of Portland cements; though it disintegrated the slag cements, which were certainly bad, yet it did not act satisfactorily on those which were doubtful.

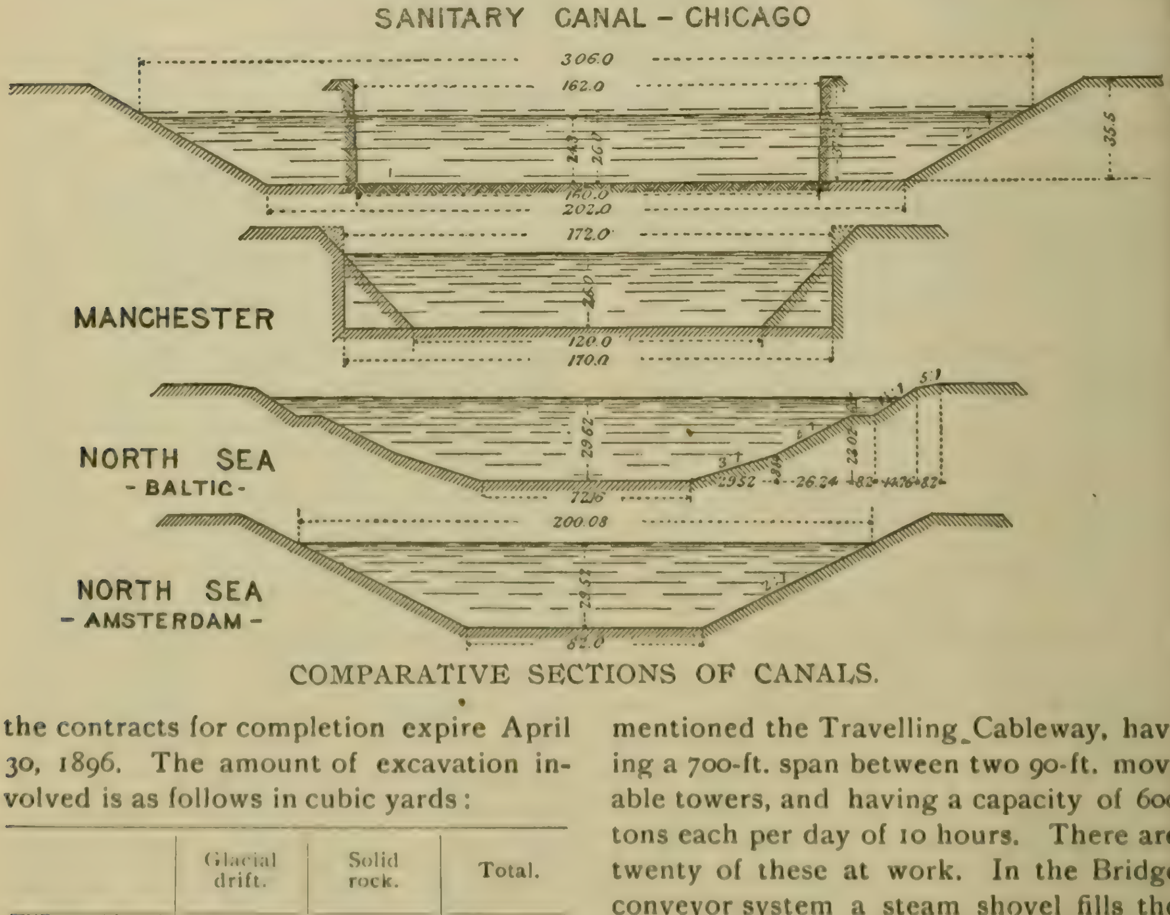
"*Natural Cements.*—None of the heat tests were found suitable, and a hot-water test (at 50° C.) was recommended.

"*Hydraulic Limes.*—Same conclusions as for natural cements."

The article concludes as follows: "It appears from these tests that the use of the hot water gives a really accelerated test, since it is ended in 6 hours. No hydraulic lime or cement notoriously bad can escape the boiling test. It remains to be proven that all cements unable to stand the test are really bad."

The Chicago Drainage Canal.

THE trade catalogues of many of our most enterprising firms are often important contributions to knowledge, and deserve a place upon our library shelves. Of this type is a booklet of seventy-two pages with forty-four half-tone illustrations, giving a full description of the work in progress and the construction methods employed on the new Chicago drainage canal, and incidentally it describes the machines manufactured by the company itself, with their actual performance on the work. The book is supplied gratuitously by the Lidgerwood Manufacturing Company, with the title, "Contractors' Methods Employed on the Great Chicago Drainage Canal." Some of the most interesting features are thus described: "The main drainage channel of the sanitary district of Chicago extends from the south branch of the Chicago river, at Roby street, southward to Lockport, in Will county. From the end of the canal proper its flow will be conducted down a sharp declivity through the city of Joliet, then by way of the Illinois river to the Mississippi. In addition to performing the duty of a drainage channel, the completed canal will be a free ship channel, navigable for boats of 22 ft. draft. The work of the district will constitute about two-thirds of the entire cost of a ship waterway from Chicago to the Mississippi river, and it will be of as great depth as the channel between St. Louis and New Orleans upon completion of the government work upon the Mississippi." The work was divided into mile sections, and consisted in the removal of earth, glacial drift, and limestone rock. The accompanying illustration will give the dimensions of rock and earth sections. The canal follows the course of the Desplaines river, which is subject to extreme floods, so that at one point a channel 13 miles long, bottom width of 200 ft. and side slopes 1 to 1, had to be constructed; and at another point 19 miles of levee was built to divert the river and save the canal from the effects of violent floods.



COMPARATIVE SECTIONS OF CANALS.

"The work was begun Sept. 3, 1892, and the contracts for completion expire April 30, 1896. The amount of excavation involved is as follows in cubic yards:

	Glacial drift.	Solid rock.	Total.
Main channel	25,945,756	12,071,668	38,017,424
River diversion	1,300,900	229,175	1,530.075
Total	27,246,656	12,300,843	39.547.499

"There will also be 348,958 cu. yds. of retaining wall and 1285 cu. yds. of slope rock. Of the total excavation required, 45.43 per cent. was completed on Jan. 31, 1895. The estimated cost of work under contract is about $19,000,000, and the total estimated cost of construction, both that under contract and that to be contracted for, and including the engineering and superintendence, in round numbers is $23,875,000. The estimated cost of the completed canal, including right of way and all expenses, will be $27,303,216.

"The cross section of the sanitary canal is greater than either the Suez, the Manchester, or the North sea ship canals. The depth at low water is 22 ft., at high water 26 ft., while the mean, under ordinary conditions of the lake, will be 24 3-10 ft."

Among the various types of excavators and conveyors used in this work may be mentioned the Travelling Cableway, having a 700-ft. span between two 90-ft. movable towers, and having a capacity of 600 tons each per day of 10 hours. There are twenty of these at work. In the Bridge conveyor system a steam shovel fills the cars, which are hauled up an inclined bank on the movable bridge from which they are dumped. The steam shovel capacity is 825 yds., though the conveyor could easily handle 1300. There was some trouble with the Steel Belt Conveyor through collapsing of the framework. The 22-in. Rubber Belt Conveyor, with an average capacity of 777½ yds. per 10 hours and a maximum of 1100 yds., was charged by a steam shovel and discharged from a bridge. The material is clay and sand. In the Desplaines river black muck from 2 to 20 ft. in depth was excavated with great economy by powerful hydraulic dredges.

The muck is cut out by a revolving steel cutter and drawn through "a 20-in. suction pipe into a centrifugal pump, which forces it through an 18-in. discharge pipe, sometimes a distance of 4000 ft. to a settling basin." The average capacity was 2500 cu. yds. in 10 hours, the maximum, 7000 yds. in 12 hours. The pump had a capacity of 17,000 gallons per minute, and the water carried 8 per cent. of solid matter.

Double Inclines, Half-Loop and Single Loop Inclines, Tipple Inclines, methods of building retaining walls having 2 ft. batter and 4 ft. wide at top, and the method of using the Self-Filling Scraper, are fully described. This work is very interesting as representing a large variety of excavation methods operating at their highest efficiency.

Strength of Bridge and Trestle Timbers.

THE committee of the Association of Railway Superintendents of Bridges and Buildings made a report at the recent New Orleans meeting, of which the following is an abstract. The conclusions are condensed from a report in the *Engineering News* (Oct. 24), and are here given.

(1.) Timber of the same species varies in quality so much that limits of strength are hard to define. (2.) Local timber classification is often inaccurate and confusing. (3.) Variations in strength are generally directly proportional to the density or weight of timber. (4.) Seasoned lumber is stronger than green lumber. (5.) Structures should be designed for moderately seasoned lumber. (6.) Age or use does not affect the strength of timber, unless decayed or checked. (7.) The elastic limit is not well defined. (8.) Knots reduce the strength of timber. (9.) Heart wood is liable to season-checking and failure by longitudinal shearing. (10.) Top-logs are usually not so strong as butt-logs. (11.) Compressive tests give the most uniform results, and should be employed for comparisons. (12.) When the length exceeds twenty times the least cross section, the column fails by "buckling." Long column formulas must be employed where the length exceeds fifteen times the least diameter. (13.) Eccentric loads and uneven end-bearings are more hurtful than is usually supposed. (14.) A long column composed of several sticks has the same ultimate strength as each component stick would have, if considered

AVERAGE SAFE ALLOWABLE WORKING UNIT STRESSES IN LBS. PER SQ. IN.

Kind of Timber.	Tension.		Compression.			Transverse Rupture.		Shearing.	
			With grain.						
	With grain.	Across grain.	End bearing.	Columns under 15 diams.	Across grain.	Extreme fiber stress.	Modulus of elasticity.	With grain.	Across grain.
Factor of safety	Ten.	Ten.	Five.	Five.	Four.	Six.	Two.	Four.	Four.
White oak	1,000	200	1,400	900	500	1,000	550,000	200	1,000
White pine	700	50	1,100	700	200	700	500,000	100	500
Southern, Long-leaf, or Georgia yellow pine	1,200	60	1,600	1,000	350	1,200	850,000	150	1,250
Douglas, Oregon & Washington fir or pine:									
Yellow fir	1,200	...	1,600	1,200	300	1,100	700,000	150	....
Red fir	1,000	....		....		800	....	.	....
N'th'rn or Short-leaf yellow pine	900	50	1,200	800	250	1,000	600,000	100	1,000
Red pine	900	50	1,200	800	200	800	600,000	. .	...
Norway pine	800	..	1,200	800	200	700	600,000	...	....
Canadian (Ottawa) white pine	1,000	....	....	1,000	....	....	. .	100	....
Canadian (Ontario) red pine	1,000	....		1,000	. . .	800	700,000	100	
Spruce and Eastern fir	800	50	1,200	800	200	700	600,000	100	750
Hemlock	600	....	...	800	150	600	450,000	100	600
Cypress	600	....	1,200	800	200	800	450,000	...	. .
Cedar	800	....	1,200	800	200	800	350,000		400
Chestnut	900	....	....	1,000	250	800	500,000	150	400
California redwood	700	.	....	800	200	750	350,000	100	....
California spruce	. .	...	....	800	....	800	600,000		....

as a column by itself. (15.) Bearing areas should be so proportioned as to prevent indenting or crushing the fibres, and thus increasing the liability to decay.

The table presented contains figures recommended by the committee for the average allowable unit stresses used in working designs.

Construction Standards.

SOME of the most useful contributions to technical information come from men actually engaged in the practical work of which they speak. Of this character is an address by Mr. C. C. Schneider, chief engineer of the Pencoyd Iron Works, on "Details of Construction of Engineering Structures," which is reprinted by *The Engineering Record* (Oct. 26). After presenting a vast amount of practical suggestions and going into minute details in the requirements necessary for good drawings in structural work, he concludes: "In order to have some uniformity in the shop work, it is necessary to have a system of standards, which are used by every engineer in the office to assist him in making detail and shop drawings. This system of standards, however, should not be carried so far as to include details of construction, but should only cover such general points as the rivet spacing for different shapes and sizes of rivets, the sizes of eyebars, pins, nuts, lattice bars, clevises, turnbuckles, upset ends of rods, beam connections, etc. Standards have the advantage, besides that, of making the work more uniform, of relieving the draughtsman of considering these little points every time he makes a drawing, which would take a good deal of his time. These standards have generally been worked out by experienced men for the benefit of those employed in the office, and will, therefore, be productive of better results than if everyone, and more particularly those of little experience, would decide upon the dimensions, etc., which are given by the standards. This system of standards has been in some cases abused by including details of construction. This I consider bad practice, as it prevents the designer from exercising his own judgment and ability and from making improvements. The designer simply becomes a machine which manufactures designs. I know of cases where complete standards for constructive details were marked out for all the details of railroad bridges of different spans, under the supervision of the engineer in charge of the office, thus making machines of his assistants, who were simply manufacturing designs by joining together a lot of ill-advised details, the results of which consisted in a lot of structural monstrosities, samples of which are yet on exhibition on some of our railroads.

"In concluding my remarks on drawings for structural work, I would take the liberty to make a suggestion, referring to the instruction of students in the way of making drawings somewhat similar to the way they are made in actual practice. Instead of stretching a piece of paper on a drawing-board, let it be simply tacked down with thumb-tacks, make the drawing in pencil, and then make a tracing of the same. This will give the student an opportunity to get some practice in making tracings, which would be of some advantage to him when he enters practical life in the profession."

Tests of Commercial Timbers.

THE Association of Railway Superintendents of Bridges and Buildings, at their fifth annual convention in New Orleans (Oct. 15), passed a series of resolutions commending very highly the work of the government on forestry. One of these resolutions is stated thus: "Resolved, further that we ask our representatives in congress to make liberal appropriations for the continuance and more rapid advance of this work, in order to secure, as quickly as possible, the much-needed information, believing that the government alone is in a position to secure it, and that it is true economy to provide it without delay." This shows that both the department and the association mentioned are alive to the times, the first in giving information which is needed, and the second in knowing "a good thing when they saw it."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Bridges.

2005. The New Terminals of the Brooklyn Bridge. Ill. (A brief account of the recen changes made at the terminals of the Brooklyn Bridge). Sci Am-Oct. 19. 800 w.

2112. Strength of Bridge and Trestle Timbers. (Report of a committee of the Am. Asso. of R. R. Supts., Walter G. Berg, Chairman. Gives a great deal of valuable data with a recommendation to the profession that the average units for the ultimate breaking stresses of principal timbers used in bridge and trestle building—derived from the investigation and presented in tabular form for different materials—be generally adopted). Ry Rev-Oct. 19. 2000 w.

2151. Suspension Bridges. Leffert L. Buck (Extracts from a lecture, reprinted from the *Polytechnic.* A very readable article discussing the advantages and disadvantages of such suspended structures). R R Gaz-Oct. 25. Serial. 1st part. 2500 w.

*2166. The Superstructure of Railway Bridges. J. F. Conradi (Advocating the adoption of standard regulations respecting live loads, and submitting some standard designs for railway bridges). Eng, Lond-Oct. 18. Serial. 1st part. 3500 w.

*2401. The Design of English Railway Bridges of Moderate Span. Walter Beer (The author says more attention should be paid to "rolling" and "dead" loads, to varying unit stress, and to accessibility of all parts. The article takes up in turn (1) determinations of "live" and "dead" loads; (2) dimensioning; (3) examples of railway bridges, and (4) specifications, tests, etc.). Eng Rev, Lond-Oct. 21. 1700 w.

Canals, Rivers and Harbors.

1923. Prospects for a Ship Canal from the Great Lakes to the Hudson. Thomas C. Clarke (A paper read at the first annual meeting of the International Deep Waterways Asso. The discussion in full with appendix. The best paper read before the Cincinnati convention thus far. Special attention to the question of economy. Will it pay?). Eng News-Oct. 10. 4000 w.

1924. A Deep Waterway from the Great Lakes to the Ocean (Editorial consideration of the various views with comments upon the difficulties attending the construction and operation of a ship canal). Eng News-Oct. 10. 2400 w.

1938. The Isthmian Canal. C. F. Z. Caracristi (Some interesting statements regarding the Panama and Nicaraguan routes. Their international bearings and engineering features discussed. Mfr's Rec-Oct. 11. 3000 w.

*1946. The Ship Canal from Bruges to Heyst. From the *London Times* (A brief account of the work to be carried out, and of various opinions, pro and con, as to its value to the city. It will cost about 39,000,000 francs). Arch, Lond-Oct. 4. 1000 w.

*1973. Weirs in Rivers. F. G. M. Stoney (The effect of fixed and movable weirs in flood time; four illustrations of Stoney's system of using an iron sluice girder). Eng, Lond-Oct. 4. 2200 w.

*1975. The Port of Rouen and Inland Waterways (The effect of canal and river navigation on inland commerce, with some interesting figures of rates and a traffic diagram of French waterways). Eng, Lond-Oct. 4. 1800 w.

*2048. The Corinth Canal. Henry E. P. Cottrell (Giving the advantages of the various ship canals of the second class, proposed and completed, with a historical and detailed description of the Corinth canal, which connects the Ionian Sea and the Archipelago, effecting a saving of 120 to 180 miles to navigation. Map). Engng-Oct. 4. Serial. 1st part. 1500 w.

2054. Modern Methods of Canal Excavation. Isham Randolph (Abstract. A historical review with a statement of the comparative merits of the various shovel excavators, conveyors, etc., used in the excavation of the Chicago drainage canal, by the chief engineer in charge of the work. Read at the Cleveland Deep Waterways Convention). Eng Rec-Oct. 12. Serial. 1st part. 2000 w.

2090. The Seattle Canal and Land Reclamation Enterprise. Ill. (A seven million dollar enterprise, requiring five years for completion, consisting of waterways and canals connecting Elliott Bay, Wash., with Lake Washington, a distance of 20,785 feet. An interesting article). Eng Rec-Oct. 19. 2000 w.

2093. Flood Protection at Williamsport, Pa. (Report of Maj. Charles W. Raymond, U. S. Corps of Engineers, and Mr. L. Y. Schermerhorn, recommending the removal of a dam above the city, and of some R. R. bridge approach embankments, removing island and pier obstructions in the channel, and building of embankments to confine the water to the channel, and also the use of a pumping plant to drain flooded areas). Eng Rec-Oct. 19. 3800 w.

*2247. New Harbor Works at Palermo (A report from E. M. de Garston furnishing particulars regarding public works about to be carried out in Palermo, including proposed dry dock, jetty, further quay frontage, and other harbor improvements). Bd of Tr Jour-Oct. 1400 w.

*2326. Improvements in the Ports of Ipswich and Harwich (The shortening and deepening of the estuary channels allowing vessels of 19½ feet draught to come up to the dock). Eng, Lond-Oct. 25. 1800 w.

2394. The Proposed Improvement of the New York State Canals (Editorial discussion of the measure before New York voters to appropriate $9,000,000 of state money to the deepening and improvement of the Erie canal. The conclusion arrived at is, that the proposed improvements would be a wise measure). Eng News–Oct. 31. 2900 w.

2456. Hydraulic Dredging Steamer "Gen-C. B. Comstock." Ill. (A 177×35½×16 foot boat having two centrifugal pumps with a capacity for sand of 1000 cu. yds. per hour, two hopper reservoirs holding 500 cu. yds., 15-in. suction and discharge pipes; self-propelling and steam steering; and altogether a quick working dredge. It is used to deepen Galveston harbor, Texas). Eng News–Nov. 7. 1500 w.

Hydraulics.

2237. Concrete Foot Wall, Queen Lane Reservoir Repairs, Philadelphia. Ill. (Brief mention of the details of a contract to repair a leaky reservoir for Philadelphia water-works. These leaks are to be prevented by foot-walls reaching to rock bottom, placed at the bottom of the inside slope, and, if possible, by the use of an asphalt lining). Eng News–Oct. 24. 450 w.

2396. A Peculiar Accident to the Settling Basin at St. Louis, Mo. Ill. (The water works settling basin is confined by a 15-ft. high wall of cement masonry, which bridged a washout under it, a distance of 61 feet, without sign of fracture. The water penetrated the bottom consisting of 18 inches of puddle covered by 6 inches of concrete, raising the bottom and washing out the underlying sand). Eng News–Oct. 31. 450 w.

Irrigation.

*2044. The Irrigation Problem in California. W. S. Green (A very general talk on the political influence brought to bear on irrigation schemes in California). Overland Monthly–Oct. 2200 w.

*2320. Underflow as Related to Irrigation. H. V. Hinckley (An important problem of the western states fully discussed. A consideration of the public importance of the underflow and the necessity for understanding it). Eng Mag–Oct. 3500 w.

Miscellany.

1969. Chemical Preservation of Timber. (Specification in full as used by a prominent Florida creosoting company, giving the conditions regarded as essential). Ry Age–Oct. 11. 2400 w.

*1971. The Brighton Dyke Aerial Ropeway (Description of two suspended cable ropeways to carry passengers; illustrated by sketches and section of structure, with details of mechanism; oil engine motive power). Eng, Lond–Oct. 4. 800 w.

*2032. Stopping a Troublesome Slide at a Summit Tunnel. John D. Isaacs (Illustrated description of tunnel and retaining wall of concrete monolith on the Santa Cruz Division of the So. Pacific R. R., with discussion). Jour Asso of Eng Soc–Sept. 3300 w.

†2182. The Maintenance of English Roads. Sidney M. Johnson (The system by which English roads are maintained under County Councils with cost, and discussion). Eng Soc of the School of Prac Sci–No. 8. 7000 w.

†2184. The Country Roads of Ontario. John A. Duff (Showing how the English system of maintaining roads is applicable to Ontario, with estimates of cost. A comprehensive paper going fully into the subject, with discussion). Eng Soc of the School of Prac Sci–No. 8. 9500 w.

†2189. On the Use of Asphaltum in Engineering Construction. Frank N. Speller (Historical sketch followed by its application to reservoirs, masonry, paving, etc.). Eng Soc of School of Prac Sci–No. 8. 6500 w.

*2212. Temperley's Patent Transporter. Ill. (A single rope conveyor with I beam track and automatic traveller for inside or outside work, adaptable for unloading vessels or cars). Min Jour–Oct. 19. 1200 w.

2288. Testing Pacific Coast Timber (Results obtained with Humboldt redwood showing the strength per sq. in. to be—tension 6521; compression 4385; compression transverse, 966; longitudinal shear, 548). Min & Sci Pr–Oct. 26. 600 w.

*2328. The Gigantic Wheel (Description of method employed in erecting a large wheel of the Ferris type at Earls Court in connection with the Empire of India exhibition. Illustrated by view and drawings of details). Eng, Lond–Oct. 25. 1600 w.

2353. The "Monobar" Conveyor Chain. Ill. (A gear driven flight conveyor in which pulsating motion is made uniform by varying the diameter of the pitch line in the driving gear wheel). Am Eng & R R Jour–Nov. 1. 800 w.

†2370. Tests of Cement Mortar Mixed With Various Kinds of Sand. Ill. A. S. Cooper (Experiments made to determine whether fine sea sand was superior to coarse sand for cement mortar. The coarse sands, over $\frac{1}{12}$ in. diameter, are found better. In finer sands, under $\frac{1}{60}$ in. diameter, there was no appreciable difference). Jour Fr Inst. Nov. 2500 w.

2391. Erecting Viaduct Trusses Without False Work. Ill. (The floor of the viaduct is 80 to 100 ft. above ground, and the truss spans of the Pratt type vary from 108 to 162 ft. in length. The trusses were put together on the ground and hoisted into place on the four column towers). Eng News–Oct. 31. 600 w.

2395. A Cement Testing Machine and Concrete Mixing Plant. Ill. (The single beam cement tester is weighted by an inflow of water, measured by a gauge on the exterior of the vessel. The cement is mixed with sand in a "tumbler" consisting of a cubical box having the shaft fastened to trunnions fixed at diagonally opposite corners). Eng News–Oct. 31. 400 w.

2455. Beaver Valley Land and Irrigation Co.'s System in Southwestern Utah. W. P. Hardesty (A reservoir and dam for storing water for irrigation purposes. The dam will be 1800 ft. long, less than 8-ft. high for 1000 ft. and 14 and 25 ft. for the remainder of its length. About 50 sq. miles will be watered, the water rights being $10 per acre and 50 cts. annually for maintenance). Eng News–Nov. 7. 1500 w.

DOMESTIC ENGINEERING

Ventilation of Gas-Lighted Rooms.

DEALING with this subject in a paper read before the recent convention of the American Gas Light Association (*Progressive Age*, Nov. 1), Mr. Irvin Butterworth corrects several current errors relating to ventilation.

"When Holmes's deacon set about building his famous 'one-hoss shay,' he uttered a piece of invincible logic that is just as applicable to the gas business as it is to chaise-building when he said that 'the weakest spot must stand the strain,' and that the way to fix it is 'to make that place as strong as the rest.'

"Every good thing—even the gas business—has its 'weakest spot,' and gas men should look their business squarely and honestly in the face, locate this spot, and immediately proceed to do what they can toward making it 'as strong as the rest.'

"We do not make a very damaging admission when we confess that the electric light man's strongest 'talking point' against gas—in fact, practically his only one—is that its use for illumination is attended with more or less generation of heat and vitiation of the atmosphere. Let us frankly admit this, but forthwith set about, not only to prevent his making more of the point than the facts warrant, but also to reduce its present actual standing ground to still smaller limits. Much can be done in both directions. We can determine and publish to the world just how much of fallacy there is in the popular impression that electric lighting is more healthful than gas lighting, and see to it that its superiority in this respect is not exaggerated to our detriment; and we can courageously grapple with the difficult and complicated problem of the ventilation of gas-lighted rooms, with excellent chances, in my opinion, of securing good practical results that will aid materially in maintaining and increasing the popularity of gas lighting."

Mr. Butterworth charges that the subject of ventilating gas-lighted rooms has been neglected both in American gas journals and by gas engineers, and he delicately hints that gas men mav have despaired of any further advance in this direction, and "tacitly agreed to maintain a discreet silence about it." He then reviews the line of inventions which have represented efforts to remove the products of combustion of gas lights, commencing with self-ventilating burners, of which the first one of all is credited to Prof. Faraday. They are objectionable as being unsightly, expensive, and troublesome. They absorb light, radiate heat, are affected by down drafts through their main tubes, hoods, etc., and do very little toward ventilating the room as a whole. But the ventilating gas lamps of the Siemens-Lungren type, which are of comparatively recent origin, are declared to be free from most of the objections named.

"There is no question whatever but that these ventilating gas lamps furnish an absolutely perfect means of simultaneously lighting and ventilating rooms and incidentally preventing the blackening of ceilings. They have received the enthusiastic praise of the most eminent gas engineers and scientists. With two such lamps Mr. Bransept extracted 5000 ft. of air per hour from a room, the temperature of which increased only 4 deg. F. after the lights had burned for 4 hours. Prof. Lewes extracted 5000 ft. of air per hour with one lamp, and also found that the radiant heat from such a lamp only raised the temperature at a point 5 ft. below the lamp, only 2 deg. F.; while Mr. Simmance secured ventilation so efficient that the temperature increased only 1 deg. F. after hours of lighting; and he goes so far as to say that such lamps can be made to carry off three thousand times as much air as there is gas consumed. A lamp burning 16 ft. per hour would therefore be able to extract 48,000 ft. of air per hour. Practical tests of these lamps have repeatedly and abundantly demonstrated that the same gas that will adequately light a room will at the same time adequately ventilate it, and that the lighting and the ventilating are both better done than is possible when an electric light is used."

It is asserted that the cost of these lamps is the chief cause that has prevented their wide adoption for public halls, stores, etc., but it is also admitted that they are not ornamental, that they are not adapted to use in dwellings, etc., and that, although they are mechanically a complete success, something simple and more easily applied must be sought. Mr. Butterworth thinks a special flue running at the side of a chimney or up through the center of a building, and ventilating registers near to or in the ceiling, would meet all the requirements of the case. This has been tried over and over again. It takes away very thoroughly the products of gas combustion. But, as a matter of fact, an unventilated room lighted by electricity is nearly or quite as unwholesome as though it were lighted by gas. The discomfort of heat is admittedly greater on the side of gas, but in a room ventilated from apertures near the ceiling the heat of the gas becomes an active agent in effecting the removal of vitiated air, thus giving to gas a superior advantage. The article fully exposes the following alleged popular errors: (1) That electric lighting is more healthful than gas lighting; (2) that carbon dioxid is extremely dangerous; and (3) that the quantity of carbon dioxid present in a gas lighted room is of itself a measure of the impurity of the atmosphere therein.

How To Reduce Gas Bills.

THE *Journal of Gas Lighting* gives advice on this subject, taking as a text an article in the *Daily News* (London). As the advice is good, we will give our readers (many of whom doubtless grumble at the regularly-presented, inevitable, and sometimes exorbitant demands of the gas companies) an abstract of it. How many of them ever think, when the bills seem unduly large, that the fault most likely lies at their own door, and that in nine of every ten cases of complaint, and probably a much greater proportion, the gas companies have charged for exactly the gas that has been consumed *and wasted*. For a great deal of gas is wasted in unsuspected ways by consumers. Happily, as our contemporary shows, it is not so much technical knowledge that the average gas consumer needs for keeping his bills within bounds, as the application of a little common sense and care for his own interest.

"It is, we suppose, inevitable that a popular writer on the subject of domestic gas consumption should have his little joke about the tricky and mendacious meter. Gas officials know that there is another side to this picture, and also that mendacity and intention to deceive are not more conspicuous in the much-maligned meter than they are in some of those members of his household to whom the consumer is in the habit of referring for information as to how much gas is used in the house when his back is turned, and in regions to which the head of the household rarely penetrates." The *Daily News* article lays due stress upon considerations of the latter order, and wisely reminds the householder "that now and henceforward is the proper time to look after gas burners unnecessarily or improperly used, and that it will be too late to do so when the bill for the Christmas quarter comes in. A wasteful habit of lighting the gas in bed-rooms and in little-used passages at night-fall and leaving the flames burning at the full until the house is shut up for the night is easily acquired by young people and servants about this season of the year, when long evenings are yet a novelty. Unless this extravagance is checked betimes by some person in authority, an enormous quantity of gas will be passed through the meter without anybody suspecting the fact; and then, when the bill comes in, there is an explosion—though not of coal gas; and, of course, nobody knows how or why so much gas has been consumed."

The writer mentions with favor the growing employment of gas-burners with flash-lights, which enable the flame to be turned on or off at will, thus imparting to gas one of the most admired advantages of incandescent electric lighting. He also observes with truth that, next to the supervision of servants and the wants of out-of the-way burners, the matter of pressure is probably the most important consideration and the one most generally overlooked. He proceeds to give some perfectly correct directions as to the proper way to burn gas by means of open flames, so as to get the full lighting advantage from it, and points out the wastefulness of consuming gas at too great or too little pressure. Curiously enough, says *The Journal of Gas Lighting*, "he just stops short of giving the full practical value to his advice by recommending the use of governor burners. It is true, he declares that, unfortunately, the photometer does not form any part of the appliances of an ordinary household, or gas consumers would soon realize pretty clearly that some form of regulator is indispensable, if they wish to get full value for the gas they pay for. But he omits to mention that, for a few pence each, there are regulator burners to be had, any pattern of which will save its cost many times over in the course of a winter's quarter, as compared with the waste of an unregulated burner."

It may be suggested that distributing engineers occasionally, from want of thought, bring their employers into disrepute by failing to notify consumers when considerable alterations are effected in the ruling pressures of a particular district. Every year, in the ordinary way, districts discovered to be getting an insufficient supply are provided with larger mains, and trunk mains are run to distant points with the praiseworthy object of equalizing pressures. This is all very right and proper. But it sometimes happens that consumers who have become habituated to low-pressure conditions suddenly get the offer of a largely, increased supply as the result of main-laying operations of which they have been kept in profound ignorance. In such cases they may or may not notice that their gas is better than it used to be. But, when the next quarter's bill comes to hand, they are sure to be startled at its unprecedented magnitude. The gas manager rubs his hands at the increased consumption that has rewarded his improvements in distribution. But the consumer rages, and is not to be pacified by any retaliatory measures short of ordering out all the gas-stoves and gas-fires in his place, and perhaps investing in oil-lamps as well. Much of this might be obviated by notifying the consumers betimes of what to be prepared for. At any rate, if, after being forewarned, he is not forearmed, the fault is his own.

Fires Caused by Heating Pipes.

IT may be stated as a general fact that substances whose physical condition is such that they absorb oxygen rapidly from the surrounding atmosphere have their tendency to spontaneous combustion increased by proximity to, or contact with, heated surfaces. Spontaneous combustion in such substances takes place when their heating (the result of chemical reaction) reaches the point of ignition. The smaller the mass, the more readily will it part with the heat so generated, and hence it may occur that small quantities of oily waste, etc., which in a larger quantity would ignite, may heat, but never quite reach the temperature of ignition. It is easily conceivable of a mass which would heat spontaneously from ordinary temperature almost to the temperature of ignition that, starting to heat from a higher temperature, it might actually reach the point of ignition and burst into flame. The initial higher temperature requisite to effect such a result may be sometimes derived from a steam or hot-water pipe; hence caution should be observed in disposing of such materials with reference to heating appliances. That such caution should extend to some substances in domestic use, not generally suspected of being dangerous, is apparent from facts stated in an article in *Heating and Ventilation* (Oct. 15).

The article quotes letters—one from Mr. Phillippe Douval, chief engineer of the fire department of Quebec, and one from the city engineer of Quebec—to fortify the opinion that even low steam pressure heating pipes and hot-water pipes may sometimes originate fires in this way. The engineer referred to appears to have made some valuable observations upon this subject. He writes as follows:

"I have to remind you that it is only a few years ago—a fact of which I believe I informed you at the time—that, while I occupied the house, 54 St. Louis street, now tenanted by Dr. Beaupre, some light, cotton, children's under-clothing laid on the radiators to dry in one of the upper stories was brought to me in astonishment by my wife, and found to be scorched absolutely, as if by an overheated smoothing iron. This was during soft weather, and therefore there was nothing to rob the heaters of their super-abundant heat, due to a very hot fire at the time. This is a result which most persons are apt to doubt and even disbelieve; the idea being that the heat of boiling water or ordinary steam —that is, steam produced under ordinary atmospheric pressure — can produce no such effect; and, in truth, such a temperature cannot do so, though in course of time even this will dry some woods to an extent to almost char them and reduce them to the state of lignite, making them porous and of loose grain or fibre and ready to take fire from the merest spark which, under other circumstances, would die out ere it had time to produce any effect. But the fact is that, just as at an elevation above sea level you cannot, owing to the decreased pressure of the atmosphere, get a cup of hot tea unless boiled in a close vessel, in the same way, in these hot water plants, the temperature goes far beyond the supposed 212 deg. F., due to the water being confined and under more than atmospheric pressure. In fact, in an ordinary one-story house and attic with heaters in the basement, and where the height to the cistern or reservoir level may be 30 ft., the pressure will be two atmospheres, and the corresponding temperature of the water 256 deg., instead of only 212 deg. But in a three-, four-, or five story house with attic and heater in basement the pressure on the water in the boiler will reach three atmospheres, and even four or more for greater altitudes, and the temperatures will increase to 274 deg., 292 deg., and so on. Again, the overflow cistern, or pipe leading to it, will sometimes get out of order, or become choked or impeded in such a way that, though the height may not be greater, the pressure may be enhanced to almost any extent, and the temperature may rise to 500 deg. or more, and become capable of quickly charring the softer and resinous woods, thus robbing them of their oxygen, when, on cooling again, they take in oxygen so quick as to take fire."

Mr. Douval, in his letter, attributed a fire which occurred a few years ago in the Quebec post-office building to the placing of a lot of canvas mailbags on a hot-water heating pipe. The opinion was questioned at the time, but recently he has found confirmation of it in a fire which occurred in a house on St. Valiér street, which was caused by a hot-water pipe passing through a deafening of saw-dust in a wooden ceiling.

Removing Air From Steam Coils.

A CORRESPONDENT of *American Machinist* recommends for the sure and automatic removal of air from an extensive heating plant the employment of a steam ejector, which he regards as the only positive means of effecting the object. He describes the arrangement as follows:

"To each coil or radiator, instead of the usual pet cock, attach an adjustable automatic air valve by a piece of ⅛-in. pipe about 3 or 4 in. long, connected to the air valves by a ¼-in. pipe to a ½-in. air main, which is to follow the general course of the return main; run this air main to the boiler or the engine room, at which point attach an ejector operated by live steam from the boiler; run the outlet pipe from the ejector outdoors, either directly, or through the main exhaust pipe, to the roof, connecting in the latter outside of the back-pressure valve. Pipe ½-in. inside diameter is large enough throughout the building for the air main for ordinary cases, say, up to 5000 sq. ft. of pipe surface; above that amount of surface, the air main in basement may be ¾-in. pipe to the ejector. All of the air piping must be air-tight. A No. 1 ejector will take care of 1000 sq. ft., and a No. 2 ejector will take care of 5000 sq. ft. of pipe surface. Where more surface is to be provided for, the air system should be divided into units of about 5000 sq. ft. each. On the air main, both to and from the ejector, place a swing check valve, and on the steam supply pipe use a globe valve, these valves to be of the sizes called for by the ejector's connections, and close to it.

"A small combination steam and vacuum gage placed in the heating main convenient to the eye of the engineer will inform him of the condition of pressure in the heating system.

"By the use of the above, the air will be expelled as rapidly as accumulated by the process of condensation, therefore relieving the engine of back pressure and maintaining the heating surface in lively working condition. This method of expelling the air from heating systems is illustrated by Pictet, in his 'Treatise on Heat,' published in 1860, as having been done by M. Pelletan, and is therefore common property."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Heating and Ventilation.

*2050. The Heating Value of Coal Gas (Discusses the enormous extension of the use of coal gas for domestic heating and cooking, and suggests legislative restrictions regulating its quality, sale and distribution for these and analogous purposes). Engng-Oct. 4. 1200 w.

2055. The Carnegie Building, Pittsburgh, Pa Ill. (Description of the indirect heating and ventilating system for the lower floors and of the power plant). Eng Rec-Oct. 12. Serial. 1st part. 1800 w.

2099. Electric Heating. J. Chester Wilson (Read before the Eng 's Club of Philadelphia and published in the Proceedings. States principles underlying the production of heat by electricity; discusses the present activity in invention in electrical devices; reviews various estimates of economy, and the various applications of electric heating in the industries, to date). Am Arch-Oct. 19. 2200 w.

2102. A Hot Water Residence Heating Plant (Illustrated description of a hot-water heating and ventilating apparatus for a residence in a much exposed position). Heat & Ven-Oct. 15. 900 w.

2103. The Capacity of Fans for the Movement of Air Against Pressure. H Eisert (An able discussion of practical value with formulæ for computing capacities of fans for special conditions). Heat & Ven-Oct. 15. 2000 w.

2145. Removing the Air from Steam-Heating Coils. H. E. (Describes a combination of an ejector with the air-pipes of a heating system for evacuating the air). Am Mach-Oct. 24. 400 w.

*2230. Heating by Electricity. Ill. (The methods employed; the bad effects resulting from the use of copper; the best kind of wire to employ; other practical points mostly relating to car heating). Mach-Oct. 15. 500 w.

2307. The Ventilation of Gas Lighted Rooms. Irvin Butterworth (An able argument is herein made in support of the proposition that rooms electrically lighted require ventilation as much or even more than gas-lighted apartments, the impure air in electrically lighted rooms accumulating more in the lower part of the space than in gas-lighted rooms, on account of the lack of upward currents produced by the heat of gas-burners. It is also maintained that gas-lights do not, as a rule, vitiate the air in rooms where they are used to anything like the extent which has been and is commonly attributed to them). Pro Age-Nov. 1. 3800 w.

2368. Heating and Ventilating a Thirteen-Room School (Full description with plans and details of plant in the George St. school, New Haven, Conn. An instructive study in heating and ventilating schools). Eng Rec-Nov. 2. 3300 w.

Landscape Gardening.

2255. Special Attractions in City Parks (Editorial reply to a correspondent who advocates the introduction into city parks of all kinds of attractions that will draw the people into the fresh air). Gar & For-Oct 30. 1600 w.

2256. The Floating Gardens of Mexico. Charles H. Coe (Description of the gardens of the past and of the present day, with suggestions regarding their origin). Gar & For-Oct. 30. 1300 w.

Plumbing and Gas Fitting.

*2065. Practical Plumbing. Ill. (It is the writer's intention to give details and methods of doing actual work—many subjects which have not been practically dealt with). Ill Car & Build-Oct. 11. Serial. 1st part. 3000 w.

*2425. On the Flow of Gas in Pipes. Arthur H. Crump (A new formula for computing the number of gas lights which a pipe can carry, and conversely the size of pipe suitable for any given number of lights). Jour Gas Lgt-Oct. 29. 500 w.

Miscellany.

2104. Fire Caused by Radiator (Hot water pipes may under certain conditions, not unusual, become a source of fire risk. Conditions involving such risks are stated). Heat & Ven-Oct 15. 500 w.

*2137. Good Advice for Gas Consumers (Editorial. Economy in gas consumption. How gas bills can be kept low). Jour Gas Lgt-Oct. 15. 800 w.

*2402. Separation and Storage of Rain Water (Illustrates and describes a new apparatus for purifying rain water collected from roofs). Eng Rev, Lond-Oct. 21. 800 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading and Domestic Engineering.

The Question of Higher Voltage.

THE change from lower to higher voltage in low-pressure plants has recently attracted much attention from the fact that in one or two instances in England this change has been made, and it is now proposed to raise the voltage of still another plant from 110 to 220. This change has been made under the advice of an electrician acknowledged to be an expert, and yet, as this change relates especially to lamps, *The Journal of Gas Lighting* (Oct. 8) questions its advisability, or, at least, points out difficulties and risks attending such changes that ought to be very carefully considered in advance. An abstract of what it says follows, from which it appears that the effects of this sort of change reach a good way.

The principal question arising in connection with the alteration of pressure refers to the lamps. Hitherto lamp manufacturers have been accustomed to work to the lower standard of from 100 to 110 volts; and it is admitted that an altogether new make of lamp will be needed to meet the fresh conditions of the service. Mr. Baynes, the electrician referred to, declares that there is no difficulty in the matter, since he has had 220-volt lamps in use for 18 months, presumably at Bradford; and he further states that 8 candle lamps at 230 volts are in the market, and a high-voltage lamp of even 6 c. p. is offered. Professor J. A. Fleming has given a qualified assent to the change; but he thinks that, if the higher voltage is to become general, domestic fittings will have to be much more severely tested and inspected than has been customary. Mr. Baynes concedes the necessity of very careful inspection and testing; but he observes that this is an essential point in any well-regulated central station, and applies to any system. This is doubtless the case. But past experience has not shown that the St. Pancras installation stands particularly well in this respect; and captious critics might inquire how much more sodium the vestry expect to make in their underground conduits under the new conditions. So far as the cardinal point of the safety of users of the new high-pressure service is concerned, it is stated that there is no more risk of getting a dangerous, or even painful, shock from a 220-volt service than from one carrying half the voltage, a tingling sensation being the utmost that would be felt if two terminals were connected through the skin. Time will elucidate this question. But meanwhile it is clear enough that the changes in the higher voltage are all in the interest of those central-station undertakings that are committed to the low-pressure principle of electric distribution. So far it is a concession to the high-pressure school, which has all along contended that no system in which the mains are restricted to carry only the low voltage hitherto employed can be commercially successful over anything like an extensive area. It means burying a copper mine to command even such a compact district as that of the St. James's and Pall Mall Company; and, of course, doubling the voltage renders this copper competent to earn much more money.

There is no reason to suppose that consumers will care whether they are supplied at 110 or 200 volts, so long as they assured that their fittings will stand. But this is certainly not a time when they could be expected to incur any extra expense for adapting their fittings to a change made wholly in the interests of the suppliers. If, moreover, there is any real difficulty in procuring, at no greater cost, low-power incandescent lamps of the new pattern, the suppliers may well lose as much as they can hope to save by the new system of supply. Electricians themselves seem to hold that much depends upon the possibility of satisfying their consumers with the 8 candle lamp which has been adopted as the conventional unit for the enumeration of lamp connections. This gives but a low standard of lighting, and is confessedly inappropriate to shop and general commercial use. But domestic users are expected to be content with it; and they are not encouraged to patronize anything more brilliant. Now we hear of a 6 candle high-voltage lamp as being yet more suitable for lighting interiors. Whether or not the public will take kindly to this progressive degradation of their house illumination remains to be seen. We may be mistaken, but imagine that a glimmering "night light" on this scale is not the most hopeful weapon wherewith to attack the incandescent gas-burner. The incandescent electric-lamp trade is naturally perturbed at the advent of a change that bids fair to render all stocks valueless, and sets up a standard in a lamp manufacture to which only a few factories have yet learned to conform.

Mr. Baynes may be, and probably is, right when he says that the 110-volt lamp, like the original 50-volt lamp of Edison and Swan, is fated to become in time "a matter of ancient history." But the makers and sellers of the article so condemned are not likely to derive much consolation from this reflection. There was much trade in 50-volt lamps, which were proprietary goods, and curiosities rather than anything else. But the manufacture of 10- to 110-volt lamps has attained to very large proportions; and they will not be ousted without a struggle. Still, the industrial clock cannot be made to stand still at the bidding of those who are pecuniarily interested in arresting the flight of the moment. If the new system is good for anything, and anywhere, it must infallibly spread.

There is yet the question of fire risk, about which the insurance companies will have something to say. Dr. Fleming observes that with a three-wire system of distribution, charged throughout with a difference of potential of 200 volts between each side of the system (making 400 volts over all), conditions might arise that would throw the whole pressure upon house fittings originally calculated for 100 volts only; and this is something to be carefully weighed.

The English Postal Telegraph System.

AN abstract of the report of the English postmaster-general (*The Electrician*, Oct. 4) gives a good idea of the present status of the postal telegraph system in all but its financial aspects. Its public use has increased enormously since the reduction of rates to 6d. for twelve words, irrespective of distance (addresses being charged for). In the last 4 years the number of telegrams transmitted was increased from 33,000,000 to 72,000,000 (790,000,000 words).

In commenting editorially upon this remarkable increase in the use of the telegraph by the people at large, *The Electrician* says that "this does not by any means represent the aggregate amount of telegraphing crowded on to the wires in this country, where the press tariff is so low as to attract no fewer than 650,000,000 words annually. The aggregate for all other messages is only 970,000,000, so that the press alone appropriates two-fifths of the whole traffic, and, as the average length of each press message is 120 words, while that of an ordinary message is less than 15, it will be seen that the nominal total number of telegrams is no criterion of the actual work performed. Taking this fact into account, the business of the telegraphs has increased since 1870, not tenfold, as it is claimed, but more probably fifteen-fold. The number of offices has increased rather more than three-fold, and the mileage of wires less than four-fold. Instruments now number 26,000, against 4000 at the beginning of the period, but this increase may be set down largely to a vast augmentation in the number of small offices and minor circuits, not wholly to increase of work." It also avows the belief that, but for "accepting the best devices forthcoming from America, adapting them to the climatic conditions of the country, ... unremitting labor in perfecting fast speed instruments of English origin, and supplementing them with repeaters of original design" (thus enabling circuits having 50 words' capacity per minute to transmit 500 words per minute) "the liberal extensions of lines provided by the government for a number of years after assuming control would not have sufficed for the traffic."

The fairness with which credit is given to the United States for its share in the general advance is commendable, and not altogether characteristic of the British press in its treatment of American inventions and discoveries.

Aside from the financial status of the government, our contemporary characterizes the career of the system as splendid, both in its public utility and in its technical department. But the financial failure seems to be as conspicuous as the technical success. The report itself admits this failure. For the year ending March 31 expenditure exceeded revenue by about £154,000, which, with interest (£298,000) on the capital expenditure incurred, makes the total loss for the year about £452,000. The aggregate deficiency during 25 years of government management has been £5,859,000. The large price paid for the government purchase, the number of free railroad telegrams, and the low rate charged for press telegrams (1s. for 75 words by day and 100 words by night, while for copies only 2d. are charged for the same message), are factors in this annual loss. The report says the newspapers took advantage of these rates, no provision having been laid down that the copy must be sent to the same town as the original.

"The newspapers accordingly combined to receive from the news association messages in identical terms; and, by dividing the cost, they are enabled to get the benefit of a rate which comes nearer 2d. than 1s., the average charge being, in fact, about 4½d. per 100 words. Notwithstanding the economical arrangements which have been made for the transmission of the telegrams (5,400,000 in number, containing 650,000,000 words), the loss incurred by the post office in dealing with them is estimated to amount to £300,000 per annum.

"These unfavorable conditions have permanently affected the telegraphs. They must in any case have diminished the possibility of profit, and in the actual circumstances their effect has been to augment the loss. Moreover, new influences inimical (temporarily, if not permanently) to financial success have come into play,—namely, the reduction of the tariff in 1885, the increase in the pay of the staff, and the competition of the telephone companies for local traffic." "The proportion of the amount expended on salaries and wages to the total telegraph expenditure, which in 1881, before the revision carried out by Mr. Fawcett, stood at about 55 per cent., has since risen, as the result of that revision and the revision effected by Mr. Raikes in 1890, to about 65 per cent." The competition of the telephone will doubtless be an increasing one for years to come.

This part of the report is rather severely criticised by *The Electrician*, already quoted, which says "it is hardly an exaggeration to say that every increase of traffic is met, not by fresh demands upon the exchequer, but by the extended application of electrical devices under guidance of technical officers of the department. It is perhaps necessary to emphasize this statement, because a little further on the results are ascribed—probably by a slip of the pen—to the officers of the post office, One might with just as little truth ascribe the failure of the telegraphs financially to the engineering staff. In reality the two departments appear to be now as widely apart as ever they were, the officers in one section being all telegraphists by profession, whilst in the other they are all post-office officials. For the efficient working of the telegraph service the former are primarily responsible, and they have reason to be proud of their achievements. For the financial failure of the service the responsibility, such as it is, must always rest with the post office. We have spoken of the head of the telegraph service; but there is no such head, or, at all events, none that is at once responsible for and solicitous of the reputation of the telegraphs as distinct from that of the post office. If such an officer existed, he would not admit that the telegraphs cannot pay;

he would probably deny that they do not pay. More than one postmaster-general has declared that it is impossible to separate the accounts of the two services on anything approaching equitable lines; and, so long as the telegraph service is without any representative on the postal staff, which has the sole control of its finances, so long will the public be dissatisfied with the excuses put forward for the financial defects proclaimed year after year in the telegraphs balance sheet. It may be that the figures represent the real facts; but it would be more satisfactory if some one with an interest in the telegraph service had a hand in preparing them. In any case, supposing them to be fair and true, the responsibility must, as we have said, rest with the post office. Nobody but the post office would have so long endured the imposition of such absurdly generous press rates, or of railway free messages, or the drain upon telegraph revenue due to private telephonic enterprise."

Adequate Telephone Systems.

THE following is an abstract of a paper read by Dr. J. R. Bennett at the recent meeting of the British Association.

A country may most properly be said to be well telephoned when its smaller towns and villages enjoy telephone facilities, for the existence of a few large exchanges in the capital and chief towns does not entitle it to that distinction. For instance, France, Russia, and Portugal all possess good exchanges in their capitals, but are nevertheless badly telephoned as a whole, since their smaller towns and villages are excluded from the circle.

On the other hand, the grand duchy of Finland, under the same crown as Russia, but enjoying a different system of administration, is distinctly well telephoned. Its area exceeds that of the United Kingdom, although the greater part of its surface consists of lake, forest, and waste; its staple industries are fishing and agriculture, yet a telephone map of Finland discloses a veritable network of lines. All the towns and many of the villages possess exchanges, while the capital, Helsingfors (population 65,000), is one of the best-telephoned cities in the world. Last year there were 198 exchanges in Finland, or one to each 12,626 inhabitants. In the United Kingdom there were but 578 exchanges, or one to each 65,537 inhabitants. In proportion to its population, Finland had, therefore, more than five times as many centers of telephonic activity as the United Kingdom. Even the people of the Aland Islands, in the middle of the Baltic, find a telephone exchange so well worth paying for at the rates which are found remunerative by the exploiting company that in Mariehamn, the capital, there is an exchange telephone to every 13 inhabitants. In fact, Mariehamn is entitled to the distinction of being the best-telephoned town in the world. Another Finnish town, Viborg (population 22,344), has an exchange telephone to every 33 inhabitants, and other towns have one to 36, 37, 39, and 40.

Norway is, however, the best-telephoned country on the whole. It has a population of 2,000,000, and has little to rely upon in the world's struggle but agriculture, forestry, and fishing. Seventy per cent. of its total area is uncultivable, and another 24 per cent. is forest. It has but a half-dozen towns, the bulk of the population residing in widely-scattered villages. Yet it possesses no fewer than 256 telephone exchanges, or one exchange to each 7812 inhabitants, —more than eight and one-half times the number in the United States in proportion to population.

Sweden ranks second in the list of well-telephoned countries. Sweden possesses greater resources than Norway. It has a population of not quite 5,000,000, one-half of which is dependent on agriculture. Eighty per cent. of the people live outside the towns. A radius of 43 1-2 miles round Stockholm, equal to 5945 sq. miles, is unquestionably the best-telephoned bit of country in the world. Almost every village possesses two competing telephone exchanges, while rival systems of trunk lines place the whole of this large area in practically instantaneous communication.

Denmark, with a population of 2,250,000, chiefly agricultural, has 152 telephone exchanges,—one to every 14,369 inhabitants. Switzerland, with a population of 3,000,000, has 155 telephone exchanges.

These complete the list of well-telephoned countries in continental Europe, and it is a curious aspect of the subject that only the smaller countries are comprised in it. The least favorable result in this group is 328 persons for each exchange telephone. The indifferently-telephoned countries are the German empire (excluding Bavaria and Wurtemberg), the United Kingdom, Holland, and Belgium. Of these the German empire has one telephone to every 449 inhabitants; the United Kingdom, one to every 636; Holland, one to every 643; and Belgium, one to every 700.

The badly-telephoned countries are France, with one telephone to every 1432 people; Spain, one to every 1618; Austria, one to every 1640; Italy, one to every 2530; Hungary, one to every 3169; Portugal, one to every 3371; and Russia,—least provided,—one to every 13,102.

These and other interesting statistics are given in tabulated form in Dr. Bennett's paper.

A systematic comparison is made between rates for telephone service in different countries. In Norway, Sweden, Luxembourg, Switzerland, Denmark, and Finland the rates are very low. In the imperial German post office territory rates are fair for urban subscribers, and high in small towns. The same is true of Bavaria. In Wurtemberg rates are low in cities, but with regulations tending to restrict suburban and rural intercourse. In the United Kingdom rates are high, with regulations unfavorable to development outside towns. In Holland rates are high in the three chief towns, and low elsewhere. In Belgium rates are high in the large towns, but low rates in small towns have recently been established. In the badly-telephoned countries rates are generallyhigh, except in Austria, where the rates are fair, but where subscribers pay capital cost of their installations.

Altogether Dr. Bennett's paper, printed in full in *Industries and Iron* (Sept. 20), is one of the most complete expositions of progress in European telephony that has yet appeared.

Telephone vs. Telegraph.

THE competition of the telephone with the telegraph is telling more and more upon the receipts of the telegraph lines, both in the United States and in Europe. It cannot be said that the telegraph service has materially fallen off during the last year, but it has not materially increased, and no other cause can be assigned for its not increasing than the competition of the telephone.

This view is substantially supported in an able editorial in *The Electrical Engineer* (Oct. 16), which reviews the situation from data derived from the recent statement of the Western Union Telegraph Company and also from the report of the English postmaster reviewed elsewhere in this department. That the business of the telegraph will be still further cut into by the increasing use of the telephone is argued from the following facts set forth in the editorial referred to.

"The business of the Western Union is set forth in the following exhibit:

	1895.	1894.	1893.
Miles wire...	802,651	790,792	769,001
Offices	21,360	21,166	21,078
Messages sent........	58,307,715	58,632,237	66,591,855
Average toll per message.	30.7c	30.5c	31.2c
Cost per message	23.3c	23.3c	22.7c

"It will be seen, since 1893, the company has lost a business of over eight million messages, and that nevertheless it costs nearly 1 cent more per message to handle the business it still retains. Admitting that the Postal Telegraph Co. has drawn off the difference and added a little new business of its own, it must be obvious that there is no increase of business proportionate in any degree to the increase of population, mail matter, or telephone messages. It might be said that these are dull times, but certainly not worse than 1893, and, besides, telegraphy under old conditions should have got much traffic due to the fact that the railroads were less used for intercommunication since the great panic. But there is an utter absence of elasticity. Gen. Eckert must be congratulated that, under such a state of affairs, for which he is no wise responsible, he has been able by good management to keep up

5 per cent. dividends and show a net increase in gross revenue of $365,364. But would it not be worth while to see whether the telegraph cannot be brought up to a higher ratio than one message per year per head of population?

"Turning to the English figures, we find the deficency for the year of $2,250,000.

"In other words, the English nation has lost in 7 years over $12,250,000 on its telegraphs, and would therefore appear as a telegraphic company to be in infinitely worse condition than the Western Union, which is at least solvent and paying dividends. The number of all messages in the United Kingdom was 71,589,064, a gain of 689,566; which bears out our contention that, were England, like the United States, a free user of the telephone, she would show nearly two messages per year per head, but would find the telephone catching a very large proportion of the new business. This is shown by the fact that the gain in metropolitan messages was barely 250,000, due to the sharpness of the telephonic competition."

Year.	Receipts plus nominal value of work done for other departments.	Expenditure.			Annual interest on capital.	Deficit.
		Charged to telegraph vote.	Charged to votes of other departments.	Total.		
1888-89	£2,129 965	£1,969,324	£72,037	£2,041 361	£352,787	£265,183
1889-90	2,364,099	2,179,921	99,065	2,278,986	306,016	197,690
1890 91	2,456,764	2,265,338	123 243	2,388,581	299,215	231,032
1891-92	2,545,612	2,507,012	124,883	2,635,895	298,883	389,166
1892-93	2,528,312	2,567,019	125,975	2,692,994	298,888	465,570
1893-94	2,579,206	2,641,020	116,625	2,757,645	298,888	477,327
1894 95	2,646,414	2,675.339	124,990	2,800,329	298,888	452,803

THE ENGINEERING INDEX—1895.

Current Leading Articles on Electricity in the American, English and British Colonial Technical Journals—See Introductory.

Lighting.

*1978. Tests of Incandescent Lamps (A singularly valuable paper, almost wholly statistical. Gives results, in tabulated form, after burning 350 hours, and after 600 hours,—amperes, candle-power, and watts per candle-power,—of six tests of lamps of thirty-four different European manufacturers). Ind & Ir–Oct. 4. 1000 w.

*2041. .The Question of Raising the Voltage of Low-Pressure Electric Supplies (Difficulties that must be met. The change will therefore come about slowly if it comes at all. An altogether new make of lamp will be needed). Jour Gas Lgt–Oct. 8. 1000 w.

*2067. Stafford Electricity Works. Ill. (Historical and descriptive). Elec Eng, Lond–Oct. 11. 4800 w.

*2068. Electric Light and Power at Copenhagen Free Port (An object lesson in the practical application of electricity for all purposes in connection with dock work). Elec Rev, Lond–Oct. 11. 800 w.

*2177. Standardizing Incandescent Lamps. R. E. Richardson (An argument favoring uniformity in testing lamps and offering suggestions to this end). Elec Wld–Oct. 25. 2000 w.

*2207. The manufacture of the Incandescent Lamp in England. Ill. (The works of the Sunbeam Lamp Company, Limited, of Gateshead. described). Elec Eng, Lond–Oct. 18. 1100 w,

*2354. An Important Development in Arc Lighting (Description of a new lamp with a double globe so constructed as to exclude air containing oxygen from the carbons, surrounding them instead with carbon-monoxide; carbons are said to last 200 continuous hours without trimming.) Ind & Ir–Oct. 25. 1100 w.

*2355. The Electric Lighting of Edinburgh. Henry R. J. Burstall (Paper read before the Inst. of Mech. Eng. Description in full of all departments of works, etc). Ind & Ir-Oct. 25. 9000 w.

2389. Storage Batteries in Office Buildings. Charles Blizard (The use of these batteries as auxiliaries to the dynamos in buildings operating electric lighting plants. Advantages to be derived emphasized by data). Elec Eng–Nov. 6. 1400 w.

2421.—$1. Notes on the Reconstruction of a Small Central Station Plant. Franklin L. Pope (Consolidation of three different plants, and change from steam to water power. Paper read at Niagara Falls, June, 1895). Trans Am Inst of Elec Eng–Aug. & Sept. 6500 w.

2446. Studies of the Alternate Arc. Ill. (A review of a communication by H. Georges to the Electrotechnic Society of Berlin describing the experiments made in the last few years in the works of Siemens & Halske and Messrs. Oelschlager, Michalke & Queiss). W Elec–Nov. 9. 1500 w.

Power.

*1888. The Distribution of Electric Power at Niagara Franklin Leonard Pope and Ralph Wainwright Pope (A comparison of the differing views upon the possibilities of long-distance power transmission). Eng Mag–Dec. 6200 w.

†1903. Power Stations—The Latest Practice. Ill. (The advance made in electric power stations during the last five years reviewed. Some of the leading types in use at present examined and illustrated). St Ry Jour–Oct. 1800 w.

†1906. Long Distance Power Transmission for Electric Railways in Portland, Ore. Ill. (Power from waterfalls over long distance; three-phase transmission. Descriptive). St Ry Jour–Oct. 2700 w.

1936. Arnold's Power Station System at Fort Dodge, Iowa. Ill. (A commercial plant in operation, employing this system, installed under the direction of Mr. B. J. Arnold, described in detail). W Elec–Oct. 12. 1600 w.

1937. Electric Plow in Germany. Ill. (From report of Otto Doederlein, United States Consul at Leipsic. Describing its use in small husbandry, as well as husbandry on a large scale). W Elec–Oct. 12. 2800 w.

1962. The Two-Phase Alternating Current Power Distribution System at the Milwaukee Harvester Works. Ill. (Plant described and special features mentioned). Elec Ind–Oct. 1000 w.

1964. An Important Electric Railway Power Station. Ill. H. C. Reagan, Jr. (Description of the power house of the Hestonville, Mantua & Fairmont Passenger Railway of Philadelphia). Elec Ind–Oct. 1600 w.

1965. The Electric Rheostat and its Construction. Ill. E. D (The necessity and office of the rheostat explained). Elec Ind–Oct. 900 w.

*1986. The Benefits of Electric Traction (Having in previous articles discussed the superior merits of cable traction in many locations and under special conditions, this article has been prepared with the purpose of indicating the conditions under which electric haulage is legitimate, and even preferable to cable haulage). Ry Wld–Oct. 2200 w.

1987. Electric Railways and the Electric Launch Season of 1895. Ill. (Descriptive principally of the launches in use on the lakes at various resorts and parks. 1896 gives promise of being the best year that electrical navigation has seen in America). Elec Eng–Oct. 16. 2000 w.

1990. How to Throw on a Railway Generator. Ill. (The three usual methods of throwing a railway generator on and off the line explained for the benefit of subordinates in power stations). Elec Ry Gaz–Oct. 12. 600 w.

1994. Portable Electric Propeller for Boats. Ill. (An electric propeller, weighing but thirty-five pounds, that can be used on any row boat up to eighteen feet long. The rate of speed claimed is from three to five miles an hour). Inv Age–Oct. 150 w.

*2019. The Development of the Electrical Locomotive. Ill. John McGhee (An account of the development from the early attempts of our inventors to the realization). Elec Pow–Nov. 2600 w.

*2021. Principles of Dynamos. Ill. W. H. Freedman (Lecture delivered before the Henry Electrical Club. The rapid development of the dynamo electric machine. Not one of its principles known 100 yrs. ago). Elec Pow–Nov. 1800 w.

2036. Electricity in Railroad Work (Electric propulsion for railways considered in popular style and in nearly all of its aspects, commercial as well as constructive). Tradesman–Oct. 15. 1800 w.

2039. Long-Distance Transmission of Electricity for a Street Railway. Ill. (Plant located at Portland, Ore. Rotary converters in substations transform the three-phase current to direct current for the street railway lines. An interesting plant). Eng News–Oct. 17. 600 w.

*2064. Electricity Supply Meters. Ill. J. Warren (The writer will endeavor to give an idea of the principle underlying some of the most well-known forms of meter for registering the amount of electrical energy consumed in any circuit). Elec, Lond–Oct. 11. Serial. 1st part. 1000 w.

*2069. Distribution of Power in Collieries. Llewelyn B. Atkinson (Read before the South Wales Inst. of Eng., 1895. Pointing out how some of the difficulties under which this industry at present labors may possibly be met). Elec Rev, Lond–Oct. 11. 3500 w.

*2071. Generation and Distribution of Electric Power for Manufacturing Purposes. C. A. Stone and E. S. Webster (Abstract of a paper read before the New England Cotton Mfrs. Asso. Discusses the conditions under which it will be possible for mills and factories to effect a saving by the use of electricity). Elec Rev, Lond–Oct 11. 2000 w.

2115 Opening of the Carborundum Works at Niagara Falls. Ill. (Statement of events that led to the creation of the new works, with description of the plant). Elec Eng–Oct. 23. 1800 w.

*2163. The Electricity Works of the Great Northern Railway Company, Holloway, N. Ill. (Detailed description of an important and extensive power plant). Eng, Lond–Oct. 18. 3800 w.

*2201. Electric Travelling Cranes in Shipbuilding. Ill. (The operations of building are carried on beneath a structure 500 ft. long, 68 ft. wide and 80 ft. high, provided with travelling cranes so arranged that material may be transported from end to end, overhead, and therefore in no way interfering with the movements of the workmen). Elect'n–Oct. 18. 1200 w.

2253. Electricity on the Erie Canal. Ill. (Historical account of tests made, especially descriptive of the system of Richard Lamb). Elec Eng–Oct. 30. 3300 w.

2300. The Fair Haven and Westville Railroad Plant. Ill. (A very thorough explanation of the electric wiring of a trolley car, with many cuts from which a good idea of the complex system may be obtained). Sci Am–Nov. 2. 1000 w.

2340. Electricity versus the Canal Mule (Showing, as the result of actual test, that horse and mule boatmen will save 82% of the present rate of tonnage, and steam canal boatmen will save 55%, on the present cost, if electrical power displaces horse, mule and steam). Ry Age-Nov. 1. 350 w.

2381. Electric Propulsion of Canal Boats. Ill (An account of the official test made at Tonawanda, N. Y., on Oct. 26). W Elec-Nov. 2. 3700 w.

*2386. An Experiment in Water-Wheel Governing. Ill. William W. Handy (A description of a simple electric governor by means of which very good regulation was obtained. An experiment carried out by the author on a turbine plant supplying current for incandescent lighting). Elec Eng, Lond-Oct. 25. 800 w.

2419 —$1. Long Distance Transmission at 10,000 Volts. George Herbert Winslow (A careful illustrated description of the entire installation of the Pomona Plant with personal observations on its construction and operation by the writer, who installed the electric plant). Trans of the Am Inst of Elec Eng–Aug & Sept. 9000 w.

2422.—$1. Existing Commercial Applications of Electrical Power from Niaraga Falls. W. L. R. Emmet (Illustrated description of arrangements for supplying power, and apparatus used, with discussion). Trans Am Inst of Elec Eng–Aug & Sept. 6500 w.

2441. Calculations of the Weight of Accumulators Required for a Tramway. G. Chenet and H. Boy de la Tour (From *L'Industrie Electrique.* Mathematical formulæ enabling one to calculate rapidly the weight of accumulators required to draw a load, a, with a speed, v, along any track whatever). Elec Age–Nov. 9. 800 w.

2443. Electrical Equipment of Public Docks. Ill. (Description of the electric installation of the Public Docks & Lock Company of Copenhagen, designed to supply light and power for the loading and unloading of vessels, etc. The docks have been open since Nov. 1894). Elec Wld-Nov. 9. 2500 w.

2459. The Marvin Electric Rock-Drill. Ill. (Descriptive of the drill and the improvements made since the original machine was put on the market four years ago). Eng News–Nov. 7, 1800 w.

Telephony and Telegraphy.

*1953. The Field Telegraph in the Chitral Campaign. Ill. P. B. Luke (Paper read before Sec. G. of the Brit. Asso. by the Deputy Director of Telegraphs in India. Brief description of the system upon which the military telegraph in India is worked, and its operations) Elec Rev Lond–Oct. 4. 4000 w.

*1955. Historical Outline of the Telegraph Service since 1870 (From the Postmaster General's Annual Report, with editorial. The report deals principally with the traffic returns and the engineering department). Elect'n-Oct. 4. 5200 w.

1966. The Telegraph in Canada. Charles P. Dwight (An account of the more important telegraph associations in Canada which have existed from the start). Can Eng-Oct. 3000 w.

1988. American and English Telegraphic Falling Off (Editorial comments on the recently published figures of the Western Union Telegraph Co. and the English Postal Telegraphs). Elec Eng-Oct. 16. 500 w.

2244. The Construction of Telegraph Lines (Giving details of construction in an interesting and condensed style, including methods and precautions in wiring and insulation). Eng News-Oct. 24. 1200 w.

Miscellany.

1912. Electricity in the Italian Navy. Ill. Guilio Martinez (Written with the authorization of the Italian Naval Department. Descriptive). Elec Wld-Oct. 12. Serial. 1st part. 2300 w.

1913. Electricity in Plant Growth and Light in Chemical Decomposition. W. Stuart Smith (The object of this paper is to give a probable reason for the great variation in plant growth from year to year when there is but little apparent difference in the climatic conditions, and also to offer a possible explanation of the action of light in producing chemical decomposition). Jour of Elec-Sept. 2500 w.

1941. Reverbatory Electric Furnaces. H. Moisson (An account of what has been accomplished through the use of this improved furnace. The author feels convinced that the working of metals by means of the heat of the electric arc will be developed to a very high degree). Min & Sci Pr-Oct. 5. 1000 w.

1942. Earth Currents and the Earth Dynamo. James S. Lang (A theory of their cause). Min & Sci Pr-Oct. 5. 1000 w.

*1954. A New Battery Element. M. Morisot (Composition of element, with experiments under stated conditions). Elec Rev, Lond-Oct. 4. 900 w.

1959. Lightning and Lightning Protection. Leland L. Summers (Experiments and opinions of Dr. Oliver Lodge discussed and objections to his ideas noted. Other writers of prominence quoted. The most effective measures for protecting electrical consumers of energy are inadequate. Rules for erection of rods). Elec Engng–Oct. 3500 w.

*1976. Recent Improvements in Galvanizing (Difficulties hitherto experienced in depositing iron on zinc by electric current, claimed to have been overcome by the Cowper-Coles process. Described and illustrated with explanation of its rationale). Eng, Lond-Oct. 4. 700 w.

1989. Electrolysis of Pipes. Ill. (Suggestions for preventing the electrolysis of buried pipes. Advising that the copper returns be led back to the station by the shortest possible route). Elec Ry Gaz–Oct. 12. 1200 w.

1991. A Successful and Simple Method for Preventing Electrolytic Decomposition by Railway Circuits. Force Bain (A plan for reinforcing the return circuit is suggested, and asserted by the author to be an efficacious remedy for the trouble). Elec Ry Gaz-Oct. 12. 1000 w.

2003. The Best Way to Begin. Keppele

Hall (Advice to young men desiring to fit themselves for electrical engineers. What can be attained through practical training only—and the advantages of theoretical training). Elec Wld-Oct. 19. 2000 w.

2011. Time and Electricity (A brief account of a plan being agitated in Glasgow and London for establishing electric clocks in various places, whose time will be in electrical connection with the Observatory clock). Plumb & Dec-Oct. 1. 900 w.

*2017. Electrical Equipment of Modern Office Buildings. Ill. Joseph Sachs (Description of some of the electrical appliances in use in these buildings; especially for lighting and elevator power). Elec Pow-Nov. 4200 w.

*2051. The Late Sigmund Schuckert (Death and life record of this very distinguished German electric engineer). Engng-Oct. 4. 1000 w.

2091. A Submerged Electric Subway. Ill. (Detailed description of the conduit crossing of the Harlem River Ship Canal, New York city). Eng Rec-Oct. 19. 1700 w.

2114. The Woolf Electric Disinfecting Plant in Philadelphia. Ill. (The inauguration of the plant. Descriptive). Elec Eng-Oct. 23. 400 w.

2119. How Franklin L. Pope Lost His Life. Ills. (Details of the accident). Elec Rev-Oct. 23. 1000 w.

2133. The Thomson-Houston Regulator Patent (A statement of the case). Elec-Oct. 23. 700 w.

*2178. The Hookham Electricity Meters (Descriptive of a meter possessing features of peculiar interest. Its advantages, etc.) Elec Rev, Lond-Oct. 18. Serial. 1st part. 2300 w.

†2194. Dynamo Design. E. B. Merrill (Paper intended as a help to engineering students, who, for the first time, propose to consider the subject of designing a generator or motor for a specific purpose). Eng Soc of School of Prac Sci-No. 8. 6500 w.

*2202. The Influence of the Shape of the E. M. F. Curve, upon the Iron Losses of Alternating Current Transformers. Clarence P. Feldmann (A contribution to the controversial literature of the "true sine curve." The author adds one more to the large number of facts which tell in favor of the flatter type of curve of electromotive force. Illustrated by diagrams). Elect'n-Oct. 18. 800 w.

*2203. An Apparatus for the Demonstration of the Development of Heat in Wires by Electric Oscillations. Ignaz Klemencie in *Wied. Ann* (Descriptive of an apparatus which will show the ratio of the heat developed by a steady current and by electric oscillations and be suitable for lecture experiments). Elect'n-Oct. 18. 1200 w.

2260. The Rating and Behavior of Fuse Wires. W. M. Stine, H. E. Gaytes and C. E. Freeman (Read before Amer. Inst. of Elec. Eng. Oct. 23. Investigations of fuse wires). Elec Rev-Oct. 30. Serial. 1st part. 2000 w.

2261. The Crandall Electric Signal. Ill. (A promising invention for use on sea or land). Elec Rev-Oct. 30. 600 w.

2375.—75 cts. The Thermophone, a New Instrument for Determining Temperatures. Ill. Henry E. Warren and George C. Whipple (Results of studies and experiments with the instrument with a view to adapting it to various scientific and commercial uses). Tech Quar-July. 9500 w.

2376.—75 cts. Experiments on the Relation of Hysteresis to Temperature. Ill. Frank A. Laws and Henry E. Warren (This paper gives an account of some experiments to determine the effect of temperatures much above the normal on the dissipation of energy by hysteresis in a specimen of steel). Tech Quar-July. 3300 w.

2385. Electrical Installation. William Brophy (A description of the appliances for the generation and distribution of electric energy for lighting, heating and power purposes). Arch & Build-Nov. 2. Serial. 1st part. 2000 w.

*2377. The Charging of a Condenser. Alfred Hay (The experiments described are intended as a contribution toward the mass of experimental evidence as to the existence of the oscillations which take place in the charge or discharge of a condenser when certain conditions as to capacity, resistance and inductance are fulfilled). Elect'n-Oct. 25. 1200 w.

*2378. Some Points Connected with the Preparation of Pure Iron by Electrolysis. W. M. Hicks and L. T. O'Shea (Paper read before the British Asso. at Ipswich. Details to be attended to to insure success by this method). Elect'n-Oct. 25. 1800 w.

*2379. The Control of Transformer Losses on Converting Systems of Electrical Supply. James Whitcher (Explanation of the writer's system, setting forth the salient points clearly). Elec Rev, Lond-Oct. 25. Serial. 1st part. 2200 w.

2382. Electricity in Japan. William E. Curtis (Its growing use in that country, with facts used to illustrate the broad scheme of industrial development occupying the minds of officials of Japan). W Elec-Nov. 2. 1700 w.

2390. The Opportunities for Electricity in China and Japan. William E. Curtiss, in the *Chicago Record* (The policy of Japan is opposed to granting any form of transportation or communication to foreigners. They may invest capital and find a market for material). Elec Eng-Nov. 6. 1600 w.

2418.—$1. The Cause of Death in Electric Shock. A. M. Bleile (The work here given was undertaken with a view to elucidating the effects of larger quantities of electricity on the organism. The value of artificial respiration after death by electricity was also tested. Experiments described. Discussion). Trans. of Am. Inst of Elec Eng-Aug. & Sept. 7000 w.

2420.—$1. Alternating Current Curves. Charles E. Emery (The subject carefully considered and mathematical formulæ used to represent curves. Discussed by M. I. Pupin and Mr. Steinmetz). Trans Am Inst of Elec Eng-Aug. & Sept. 9800 w.

2445. Water Rheostats. Ill. George T. Hanchett (A few practical suggestions concerning the use of water resistances). Elec Wld-Nov. 9. 800 w.

INDUSTRIAL SOCIOLOGY

British Commercial Supremacy Endangered.

NOT long ago we heard that British orders for architectural iron work were going over to Germany and Belgium, and that in some classes of iron construction English manufacturers could no longer compete successfully with makers in those countries. *The Engineer* (Oct. 18) seems struck with surprise and fear at the turn commercial affairs are now taking in the United States. In a leading editorial we find the following, apparently inspired by a recent able review of the commercial and financial situation published in the *New York Herald*.

"All our readers are aware that trade has been extremely active in the United States for some months. The mercantile position of that country presents, however, certain startling anomalies, which are enough to make the most earnest-minded political economist doubt the soundness of his science. Thus, for example, the country has been perplexed by two contending factions, one crying aloud for free silver money, and the other denouncing free silver money as a delusion and a snare. Furthermore, gold has been leaving the country at a rate which has created, if not panic, serious apprehension, and very remarkable expedients have been adopted by the American government to keep gold in the country. Such currency conditions are most unfavorable, it may be assumed, to the development of industries or the progress of trade. Furthermore, corn has fallen in value, and extraordinarily gloomy reports of the western farmer reach the coast,—where, however, they excite little interest,—and thence travel across the Atlantic to this country, where they are received with grim satisfaction by the English farmer whom the prairie settler has done so much to ruin. Yet, in spite of all this, we hear that the statistics of American trade for the past 8 months have taken every one by surprise; and no wonder! The highest value of United States exports heretofore reached in 1 year has been about $184,000,000. Apparently these figures refer to manufactured goods only, and not to corn. Should trade continue to flourish as it has done for the last months, then the year's exports will represent $228,600,000. The most remarkable gains are those made by woolen manufactures, chemicals, machinery, and refined mineral oils. For the 8 months of this year the gain in exported agricultural implements was over $500,000; in chemicals, over $680,000; in machinery, over $1,100,000; and in refined oils, nearly $8,000,000. But perhaps the most remarkable fact of all is that, according to the *New York Herald*, the value of the exports will have exceeded that of the imports to the extent of $17,000,000 by the end of the year. On many occasions discussions have taken place in our correspondence columns on the fact—if it be a fact—that all civilized countries, with a most insignificant exception, import commodities of all kinds to a value about twice that of their exports. No quite satisfactory explanation of this has ever been given, and it is worth while to state the nature of the problem. Four principal nations—say England, France, Germany, and Belgium—trade with each other. Let us call them A, B, C, and D. For the sake of simplifying matters, we shall assume that their transactions are equal, and we shall further take imaginary sums. A imports goods to the value of £200,000,000 from B, C, and D, and exports goods to the value of £100,000,000. The same statement holds good of all four. Thus, then, the import trade of the four represents a value of £800,000,000, and the export trade £400,000,000. How is the balance struck at the end of the year? Our readers must not buoy themselves up with the hope that we are going to give them the answer to this question. The exception to the rule has, however, come at last, and the United States are exporting faster than they are importing. Now, if a country can get on and thrive while it is buying each year twice as much as its exports can pay for, it seems to be clear that a country exporting to a value much greater than that of its purchases must be amazingly prosperous. We shall not stop to ask how the United States exports are being paid for; apparently not with commodities, apparently not with gold. That point also must be left for political economists to wrangle about. The position in the United States presents us with a practical question of much more interest and importance. Has the long threatened day at last arrived? Are the United States about to become serious competitors of Great Britain in foreign markets?"

The Engineer then quotes the *New York Herald* as asserting that a new era is dawning upon American commerce, and as urging American manufacturers to make every effort to extend their foreign trade. The trepidation into which this throws our contemporary is somewhat amusing. It asserts that protection enables the American manufacturer to sell products abroad at lower prices than he gets at home, which is true,—at least of some products,—and adds that the standard of commercial morality with American manufacturers and salesmen is not up to the British standard, which is not true,—at least of many American manufacturers and salesmen. It urges English traders not to abate one jot of their honesty; as though the "weighting" of cotton goods and other similar fraudulent practices were things unknown in England, and the dealings of its trading classes in foreign and colonial markets had been always above reproach. But it betrays a curious moral squint when it says the "Yankee is clever and sharp," and that the proverb, "honesty is the best policy," is "far too crude to apply to such a case" as the one under consideration. It further says:

"We shall not say that in the long run honesty will win. If it does not win at once, it will not win at all. The theory is that, if an American sells rubbish and undersells the Englishman, after a while the purchaser will find out the difference and will buy the good article. Nothing of the kind happens. The purchaser does not in many cases know that what he has bought is rubbish. In others, rubbish answers the purpose perfectly. Then the standard of rubbish varies; and, having said this, we come to the point on which, of all others, we wish to insist, and up to which we have endeavored to lead our readers. It is that the cardinal weakness of the English manufacturer is that he will not sell what other people want to buy."

Finally, it asserts the belief that danger to British commercial supremacy is in sight, and it is altogether unhappy at the prospect. "A careful consideration of our own trade, past and present, is not comforting. It is better than it has been, but there was unlimited room for improvement. Our great shipping industries, for example, have been in a most unsatisfactory condition. Every week we publish long lists of ships launched; but what is the profit to the builders? What have been the dividends of the great building companies on the Tyne or the Wear, other than the Elswick firm? What have been the declared dividends on the Clyde? Shipbuilding has almost left the Mersey. And now we have a big strike on. The United States threaten to build ships for the whole world—and not ships only, but locomotives as well, and to roll rails for humanity in general. The potentialities of the country are enormous."

While the same is claimed for the commercial potentialities of Great Britain, its commercial methods are criticised, and it is more than hinted, in spite of the admonition not to abate honesty, that it is best to be just honest enough—not too honest.

Government Appropriations for the Maintenance of Commerce.

ANENT the proceedings of the deep waterways convention recently held at Cleveland, Ohio, *The Railroad Review* (Oct. 12) makes some editorial remarks which are directed against the general sense f that convention that the United States overnment should make most liberal appropriations for the establishment and maintenance of deep waterways to the seaboard in connection with the great lakes. The right and power of the government to do this are not questioned; neither is the mportance of a deep-water communication between the Atlantic and the lakes disputed. The policy of such paternalistic action is, however, viewed unfavorably.

The government has already expended vast sums for improvement of waterways, much of which has been wasted so far as the specified purposes of these appropriations are concerned; and, in many cases, the so-called improvements were unwisely projected. The relation of the railroads to commerce is stated as follows:

"Of late years, however, a new element has been introduced into this subject of commercial movement, which, although involving a somewhat different method of application, is nevertheless based upon the same principles as those previously controlling. Government found the waterways ready to hand and simply assumed control. Ordinary railroads, although constructed by government, were equally open and free to all who chose to traverse them, but the new element of railroads introduced a different method. While requiring government sanction and subject to government supervision, the element of private ownership was present in larger proportions than had previously been employed. The character of the service required that public vehicles should be excluded therefrom, and altogether the proprietary interest was so manifest that it has come to be accepted that, while railways in common with all other recognized channels of commerce are subject to the regulation of government, they of all such channels are not entitled to the support of government in the way of either maintenance or betterment.

"It is just possible that such a conclusion is erroneous. There are many things in common between the railroad and other channels of commerce. In order that commerce may be promoted, government exercises its rights of eminent domain in the appropriation of landed property for the purpose of constructing roads, enlarging rivers, building canals, etc., and, because of the same commercial necessity, this right of eminent domain is granted to railroads. Government also assumes to regulate the use of commercial channels, the railroads as well as the waterways and roads. It prescribes that certain conditions shall be maintained in order that the safety of passengers and property in transit may be assured, and that no interruption of, or discrimination in, the service shall be permitted, so that in many ways—in fact, all ways except that of ownership—the conditions attaching to these three channels of communication are practically analogous.

"The same is true of the uses to which these means of transport are put. Each channel is free to all who may seek to use it. A railroad is not obliged to admit to its tracks the vehicles of the public, but it cannot refuse to transport persons and property when tendered under proper conditions. Whatever may be the facts as to the conveyance itself, the service is a public one and must be open to all alike. Should this service be interrupted by force, it is now admitted that in all cases government has the right to step in and do whatever is necessary to keep the channels of commerce open. In short, the supervision, regulation, and, if necessary, the control of transportation is a government function that cannot be abrogated if the purposes for which it is established are to be maintained,—to wit, equal and exact facilities for all."

The government has, moreover, assumed "a larger supervision of railroads than of any other means of communication." It even "claims the right to control the compensation charged for service, and to direct the way in which accounts shall be kept." In view of these extremely close relations existing between the government and the railroads, our contemporary sees no grounds upon which an appropriation for the improvement of a waterway can be asked for that would not apply with equal force to a railway, and with this view we are compelled to agree. Yet, were it now proposed that such government aid should be extended to railway improvement, a wave of protest would sweep from the Pacific to the Atlantic coast.

How congress will act upon the resolutions adopted by the convention remains to be seen; but there appears no reason why they should be favorably regarded. We believe that such a waterway, if ever constructed, should be constructed by private enterprise, unaided by government.

How Work People are Housed in Berlin.

THE United States Consul in Berlin, in one of his reports, gives some interesting details of the miserable housing of the working classes in that city. The abstract of this report given herein shows their state to be pitiable. In 1890 the population of Berlin was 1,436,233. Of this number 318,753 heads of families paid income tax under the 900-mark limit (the value of a mark is between 24 and 25 cents), while an average laborer, with wife and child, should have from 1575 to 1750 marks' annual income to occupy the smallest quarters, reckoning rent at one-fifth his income.

Capital has been embarked in the building of new quarters of the city, and tenement buildings have been neglected. As a consequence there has been a failure to provide small buildings, apartments, and small suites of rooms, and, in many cases, the poor have been driven still closer together in such buildings as previously existed. The moving of factories employing many hands towards suburbs not inhabited by the rich, and the rise in the rents in the city proper, have forced the poorer classes towards the outskirts. Efforts have been made to provide laborers with small, separate houses still further out, but this is not practicable on any large scale for the really poor. They must live near their work and near the centers. It is recognized that laborers must live near together, in order to live on their present wages.

The average daily wages of an adult male is only 2.40 marks, which, at 300 working days, gives but 720 marks annually. The rent of one room and kitchen in the back part of the house, where air is poor and often foul, is reckoned, at an average, from 250 to 270 marks; rent of a room with two windows, or one-windowed room and kitchen, 315 to 350 marks; the rent of an apartment with a two-windowed front room, one-windowed back room, corridor, and kitchen, averages 450 marks. A workman, with wife and child, must, therefore, spend about 315 to 350 marks annually on his rent alone, or nearly one-half of what he makes as an average wage earner. Hence it is necessary that wife and children must work to help pay the family way, and any small floor, bed, or sofa space that can be squeezed out is let to more or less permanent tenants for the night. These sub lodgers are called *Schlafburschen*. They are of both sexes and all ages, and comprise the hard-working, sober young laborers, steady girls, widows, and widowers, as well as the floating population, which deals in and distributes vice, infectious diseases, and punishable crimes. Efforts have been made to stop this sub-letting, and the Berlin police are active in their endeavors to regulate and check such abuses. One evil result of such herding together of the sexes is the number of illegitimate children born to very young girls. The tenement house in Berlin is not so easily recognized as in some other cities, owing to the admirable cleansing and police system and the appearance of the houses, which is often imposing; but the houses themselves cover much misery. A common thing is a broad, high, massive front, broken by an arched passage, which leads to one, two, or three courts. The back courts are often ill kept, narrow, and foul, violating the rules which prescribe so many cubic feet of air to the human body. They are often old buildings, by no means calculated for the human strain to which they are subjected, and lack conveniences, especially water-closets. In these houses the worst mortality occurs in garrets, the cellars ranking next. Garrets are more fatal, perhaps, because of the greater cold, or the strain on the old and sickly from having to ascend and descend stairs; or it may be that garrets are slightly cheaper than cellars, the latter being largely rented by dealers in old rags, ron, etc., so that the poorest of the poor eople, weakened by disease and hunger, nd predisposed to greater mortality, take o the garrets. Cellars are also occupied y men and women who take charge of the leaning of the houses. Even in the best ouses the gatekeepers or *portiers* live in ery badly-lighted, badly-warmed, and ill-entilated rooms, considerably below the level of the street. In the back parts of tenement houses these evils are much worse. In 1880 as many as one hundred thousand people lived in cellars. In that year attention was drawn to the excessive crowding of the floating population in large single rooms, locally called *Pennen*, which were really breeding grounds for epidemics. The worst of these were done away with then, but there is a constant tendency to their revival, in defiance of the police. Cellar dwellers suffer from eye disease and rheumatism, owing to the lack of light and the dampness of the walls. As lately as 1893 the number of cellar dwellers was reckoned at one hundred thousand, and there is no reason to estimate them at a lower figure now.

Is it not possible for architectural skill and inventive talent to devise for people of small means better city habitations than the world has yet seen? This herding together of working people is not peculiar to Berlin; though it exists there in an aggravated form, it is found in nearly all European cities, and is an increasing evil in American cities. No problem in architecture is of more immediate and pressing importance than this.

Reconstruction of Old Cities.

A PROPOSITION which comprises a scheme for the reconstruction of old cities has been made by a London clergyman. *The Architect and Contract Reporter* (Sept. 27) apparently does not think this scheme too absurd for notice, as it reprints it. The author professes to outline a method whereby "the question of the unemployed" can be treated, and this or some similar scheme will, in his opinion, force itself upon public attention as soon as the unemployed become sufficiently numerous, and the question of providing for them becomes sufficiently urgent. This contingency, he declares, is near at hand, and the reconstruction of cities—notably London — is proposed as a solution of the question. That anything will need to be done for the unemployed after the cities are reconstructed does not seem to have occurred to Rev. Dr. Parker, who has the honor of making the proposal; or, if it has, he probably contemplates an extension of the scheme to the continuous reconstruction of cities. Tearing down cities and building them up again would continuously supply much work; that for many cities it would be superfluous work, entailing much greater expense than the wages that would be paid for it, and that, while in progress, it would more or less unfit the cities for the purposes of cities as centers of business and homes for citizens, are considerations that do not seem to have been heeded. It would cost far less to pay the (estimated) amount of wages that could be thus earned directly to the unemployed, and let them remain idle, than to carry out the scheme.

There is, however, little doubt that many old cities might be reconstructed, with benefit to all who would subsequently inhabit them; and this consideration may possibly justify Dr. Parker's scheme for the reconstruction of London.

First, a thorough and scientific system of drainage would have to be considered and supplied. "The drainage of London,' says Dr. Parker, "is unquestionably bad. It is in this direction that infinite mischief has been done by malicious or careless workmen. To my personal knowledge the drains of one of the finest buildings in suburban London have never been connected with the main sewer. What has hitherto been done in piecemeal in the way of good drainage must be done according to the scale of the whole area."

The idea of local centers is regarded as the basis of any "adequate, workable scheme of reconstruction." Accordingly reconstructed London "should be laid out in main centers, such as the railway center, the market center, the shipping center, the educational center, the hospital center, and the like.

"There should also be an ample system of subways; a London out of sight. In connection with the subways should be all gas pipes, all electric wires, all telegraph apparatus, all water-mains, and all lamp-lighting machinery, the whole so distributed as to be accessible in every part without disturbing the streets or embarrassing the traffic, and so protected as to be safe from the severest frost. The last point is of supreme importance, as shown by the memorable frost of 1895. The proper construction of subways would overcome the nuisance and difficulty connected with the removal of household refuse.

It is further suggested that the Thames might be straightened, and wharves, warehouses, and offices built after the manner in which they have been built in Liverpool. The streets could then be laid out north and south from the river, with wide east and west intersections. A seaway between London and Brighton is also suggested. Quoting Brunel as saying that the lack of money is the only difficulty known to engineering, Dr. Parker says there would be no lack of money for rebuilding London. "Parliament knows how to deal with vested interests, and we are face to face with unemployed millions which would be instantly placed at the service of any legally-constituted court at a very moderate rate of interest."

In conclusion, it is urged that the question of plans (all historical buildings to be preserved) should be submitted to the Institute of Architects, the Society of Arts, and the Institute of Civil Engineers.

The Upward Movement of Silver.

THE rise in silver both in the London and American markets has excited surprise and comment, as something generally unexpected. Yet at the time the recent issue of United States gold bonds was pending one of the Rothschilds was quoted as expressing the belief that silver might possibly yet rise to a par with gold, and *Bradstreet's* (Oct. 12), commenting editorially upon this phase in the world's financial affairs, says it was foreshadowed by the recent speculative improvement in the silver-bearing obligations of the Indian government at London.

The rise was sudden and sharp. In the week ending Oct. 19 it rose to 31 3 16 d in London, and 69 cents in New York whereas for many months the price o bars in New York has been about 67 cents per ounce.

Our contemporary also notes a significant indication; "both here and abroad there has been a sudden revival of what may be termed speculative attention to silver and its movements. This is shown by the fact that, after many months of inactivity, the silver bullion certificates, representing metal deposited with a safe deposit company in this city, have again been traded in on the New York stock exchange, which, owing to withdrawals, has shrunk to very limited proportions.

"The foundation of the movement which may be regarded as another manifestation of the tendency of all commodities to advance, is found in increasing demands and limited supplies. The large smelting organizations in this country continue to turn out silver bars up to their full capacity, but, on the other hand within the last few years, many low grade mines and reduction works operating upon that class of ores have been forced by the lower prices to either curtail or suspend their work. It is estimated, indeed, that the actual output has recently averaged about 160,000 ounces per month and this amount is easily absorbed by the demand for use in the arts and the constant shipment to Europe. The demand on the other hand, has been augmented without doubt, by the financial conditions at the east, arising from the war between Japan and China, and the expansion in the trade of British India. It is, indeed, understood that the amount of silver arriving in New York has of late been greatly curtailed on account of heavy shipments from the smelters direct to San Francisco the metal going thence to China. This, it has been found, is easier and less expensive than the custom which has obtained for some years of forwarding silver to New York and thence to London, where it is again shipped to the east.

There is, however, a belief in some well-informed quarters that both the Japanese and the Russo-French financiers who are aiding the Chinese government have been large purchasers of silver. Their operations in this respect have been conducted with great care and no small degree of secrecy. How large such accumulation may be, or what their probable amount is, cannot, of course, be even estimated, while there is also considerable doubt as to the basis for reports that certain large interests have accumulated silver with a speculative purpose in relation to the ultimate outcome of financial affairs in the two far-eastern empires."

It is also noted that "the expansion of trade throughout Great Britain's eastern dependency" is producing, and is likely to produce, an increased demand for silver in that quarter of the world. There are also indications, in the utterances of the London financial papers of recent date, of the possible coinage of a large amount of rupees. Another fact tending to advance the price of silver is its increasing use in the arts. "It is the opinion of the trade that the consumption of the metal in this form . . . . now constitutes a means by which a very considerable portion of the entire silver product of the United States" will be annually absorbed, and there is no prospect of its decrease.

"The effects of the movement, though it has barely started, upon silver mining industries and the general trade of our own western States is a matter calculated to attract general attention. It is the opinion of many authorities that a stable silver market, even a few cents higher than the recent level, would result in the reopening of many mines and smelters which have been idle for a considerable period. The effects of this, not only upon general trade interests, but upon the railroads throughout large sections of the west, can be easily appreciated, when it is recalled that the disasters which overtook a number of prominent corporations of that kind during the last 3 years are directly attributable to the heavy and persistent decline of silver."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Industrial Sociology in the American, English and British Colonial Technical Journals—See Introductory.

*1898. The Financial Outlook in America. By a Banker (The gold exports of the United States, from Jan. 1, to middle of Sept. exceeded the gold imports by $27,702,000. An attempt is made to account for this drain of gold). Bank Mag, Lond-Oct. 1400 w.

*1899. The Coming Flood of Gold. W. R. Lawson (A review of the economic history of the gold movement. The danger now seems to be the over abundance of gold. The recent progress is nothing compared to what is predicted for the future. Not only new mines, but improved processes are contributing to the supply. The right of gold to be regarded as capital has never been conclusively established. Remedy suggested for the evil of excessive currency is restriction). Bank Mag Oct. 6400 w.

†1900. Co operation in Agriculture. Henry W. Wolff (The needs of agriculture in England, with remarks on remedies tried and suggestions offered. Agricultural co operative supply has been successfully practised in France, Germany, Austria, Italy, and Switzerland. Its advantages set forth). Contemporary Rev-Oct. 4800 w.

1944. Silver's Upward Movement (The foundation of the movement is found in increasing demands and limited supplies. India's influence: Increasing use of silver in the arts. Its effects). Bradstreet's-Oct. 12. 1000 w.

1982. Government Appropriations for the Maintenance of Commerce (An editorial argument against greater propriety of any government appropriations to improve waterways, than for the maintenance of railroads). Ry Rev-Oct. 12. 1500 w.

†1997. English Industry and Eastern Competition. R. S. Gundry (Tracing the industrial complications arising from the protection of gold, and favoring the restoration of silver to its full rights). Fortnightly Rev-Oct. 5000 w.

2053. A Study of the Growth of Cities. Elmer L. Corthell (Abstract. The writer expresses the belief that the growth of the six largest cities in the world will steadily continue, and thinks that in 1920 their population will be for London, 8,344,000; Chicago, 7,797,600; New York, 6,337,500; Paris, 3,808,580; Berlin, 3,442,221; Philadelphia, 1,838,760. He gives reasons for this belief and illustrates the growth of each city on a diagram). Eng Rec-Oct. 12. 1200 w.

†2056. The Maintenance of the Gold Reserve (This able editorial shows that the amount which has to be borrowed $70,000,000 in 18 months—indicates the amount that has been wasted in maintaining the gold reserve when there has been a surplus, and estimates the expense of maintaining specie payments in the United States at $46,000,000 annually). Rhodes' Jour of Bank-Oct. 700 w.

†2057. A Popular Loan (Editorial attempt to prove that a popular loan at this time on any terms the U. S. government is likely to offer is a chimera, and that anything less than a 4% bond in gold would not sell in any quantity in the open market). Rhodes' Jour of Bank–Oct. 800 w.

*2165. The Rivalry of the United States (Editorial discussing the fact that the United States will this year export more than its imports, and considering this as an indication that this country is about to become a powerful competitor with England in the markets of the world). Eng Lond–Oct. 18. 1800 w.

2220. Reaction in Prices During the Past Quarter (Besides reviewing the trend of prices for the past quarter, this article contains a full-page tabulated comparative statement of 109 staples for 1891–2–3–4 and 5, which is an exceedingly valuable table for reference). Bradstreet's–Oct. 26. 1000 w.

2222. Labor Contests Since 1881 (A review of the so-called militant side of labor organizations, down to June 30, 1894, based upon the tenth annual report of Hon. Carroll D. Wright of the U. S. department of labor). Bradstreet's –Oct. 26. 600 w.

*2250. Customs Tariff of the Bahamas (Table of duties and table of exemptions). Bd of Tr Jour–Oct. 1800 w.

*2251. Tariff Changes and Customs Regulations (Belgium, France, Spain, Italy, Austria, Roumania, Brazil, Chili, Uruguay, British India). Bd of Tr Jour–Oct. 6200 w.

†2270. Why Does the South Want Free Silver? John T. Morgan (The extreme position is taken in this article that the use of silver money will prevent inflations and depressions of values and prices, and that it furnishes labor with the only safe and convenient measure for the value of a day's work. The interest of the South in favor of free silver is ascribed to an alleged appreciation of these assumed facts. The usual stock arguments are employed in support of these propositions. It is further alleged that the silver dollar is the most useful money for the people, that it is not dangerous to anybody, and that it never did, and never will do harm, with much else in the same vein, which while alleged, is far from being ably sustained by the arguments put forth). Arena–Nov. 7000 w.

†2272. Jingoes and Silverites. Edward Atkinson (Facts tending to prove the erroneous views advanced by the so-called "jingoes" dangerous to the country, and showing the negligence of the mass of thinking men. Arguments all favor the gold standard). N Amer Rev–Nov. 3000 w.

†2273. Industrial Development of the South. W. C. Oates (A brief summary of what is going on in Alabama at present as a typical southern state). N Amer Rev–Nov. 3600 w.

†2275. True Source of American Wealth. Ben F. Clayton (The subject is not discussed from a scientific standpoint. The writer considers the natural product of the soil, aided by intelligent labor, to be the only source from which wealth may be obtained to meet all obligations). N Amer Rev–Nov. 2300 w.

2281. Protection Required for Both (Address by Col. A. L. Conger at 2d annual meeting of the Agricultural Implement Manufacturers at Chicago, Oct. 22, advocating the "Lubin System"). Sca–Oct. 31. 1400 w.

*2290. Plutocracy and Paternalism. Lester F. Ward (An attempt to make an unbiassed analysis of the meaning of these terms in their relation to the existing state of affairs in the country). Forum–Nov. 4500 w.

*2291. Coöperation Among Farmers. Edward F. Adams (Some of the fundamental difficulties in coöperation. A description of the movement to unite the orchardists of California in marketing their fruit). Forum–Nov. 5800 w.

†2292. Principles of Taxation, David A. Wells (A discussion of the principles of taxation from a broad basis, special consideration being given to the experience of the United States). Pop Sci M–Nov. 5000 w.

†2293. Recent Tendencies in the Education of Women. Mary Roberts Smith (A review of the past methods of education for women, and their results, and predicting that woman will soon be able to obtain as broad and as specialized a training as her needs shall require). Pop Sci M–Nov. 2600 w.

†2294. The Past and Future of Gold Charles S. Ashley (An article written to present the evidence that has led the writer to the conclusion that the demonetization of silver has caused an appreciable fall in the value of gold). Pop Sci M–Nov. 3800 w.

2305. Bank Clearings Heavily Increased (These statistics indicate a trade activity and an expansion of business larger than in any previous month since May, 1893. A marked tendency toward enlarged trade in the northwest and south is also apparent). Bradstreet's–Nov. 2. 600 w.

2306. Possibilities of Trade with the Baltic. L. O. G. Amundsen (A communication from the acting Danish consul at New York, giving facts relating to commerce and indicating possible extensions of trade between the United States and Denmark). Bradstreet's–Nov. 2. 1700 w.

*2417. Production of Gold and Silver (An endeavor to ascertain what the production of gold at the present time is, and what the prospects are of its progress. A table is given of the production of gold and silver in the world since the discovery of America; also a table of the approximate stocks of money per capita in the principal countries of the world including gold, silver and paper, arranged from the highest to the lowest). Banker's Mag–Nov. 3500 w.

*2424. Upon Sundry Labor Questions (The inevitable strikes that have followed the revival of trade and which it is assumed will follow such revivals as long as the present wage system remains unmodified, are made the text for an argument favoring profit sharing as the only remedy for strikes). Jour Gas Lgt–Oct. 29. 1800 w.

MARINE ENGINEERING

Water-tube Boilers for Marine Service.

THE application of water tube boilers to marine purposes meets with the opposition usually encountered by innovations affecting a wide field of commercial operations. Some recent mishaps and partial failures have been seized upon and made the most of by those whose interests are, or will be, adversely affected by the extended employment of water-tube boilers for ship propulsion. These reviews, being independent of any such interests, may, and ought to, present views on both sides. Favorable accounts of the operation and economy of water-tube boilers have been previously reviewed. Unfavorable opinion is represented in *Engineering* (Sept. 6) by a long communication written by James Howden of Glasgow, and by a correspondent who signs himself "Argus." The latter makes a criticism of water-tube boilers for marine propulsion, and of the Belleville boiler in particular, the performance of this boiler in the Wilson liner, Ohio (late Egyptian Monarch), supplying material for such a criticism. He says these "performances were expected to prove, beyond the shadow of a doubt, the superiority of such boilers as steam generators to those of the cylindrical type, and to justify the admiralty in adopting them." Yet these performances, it is claimed, were very unsatisfactory.

The Ohio is fitted with four Belleville boilers intended to develop 1500 h. p. with a working pressure of 200 lbs. per square inch. These boilers have 192 sq. ft. of grate, 6000 sq. ft. of heating surface, and can carry a 250 lbs.' pressure; so that the normal power of the ship is less than eight per square foot of grate, and she has 4 sq. ft. of heating surface per indicated horsepower,—conditions, both as regards engines and boilers, so favorable as to be out of comparison with those of any other regular Atlantic liner; and the "woeful mess" the ship" has made of it is just as far out of comparison with their performances. These boilers represent one-eleventh of the installation in the Terrible; so, for the latter's trial power of 25,000, the Ohio should show 2200; and, unless the latter can maintain 1800 continuously at sea, the Terrible cannot maintain 20,000, which is what she is built for."

Very severe criticisms by this correspondent are followed by the question: "We want to know why this British ship, a large and fine one for her speed, with extremely modern machinery and a lavish boiler installation, should make protracted voyages, and then anchor short of her home port in such deplorable condition that a tug had to be sent to convey her home?"

"Argus" says the Belleville boiler was adopted by the British admiralty under the representation that "there was nothing experimental about it, but the Ohio's experiences show that it is all experiment."

In his communicaton, Mr. Howden promises a future letter to prove from actual facts the inferiority of water-tube boilers for marine use. He asserts that they consume more coal per power unit than cylindrical boilers, and require a greater number of stokers for a given power. He declares that, when the debate on water-tube boilers in parliament last April was on, "the only case known . . . . in which water-tube boilers had been tested under equal conditions, at a fairly high power, against cylindrical boilers, was that of the Newhaven and Dieppe steamers Tamise and Seaford, the former having Belleville boilers and the latter cylindrical boilers"; and he adds: "In my letter to the *Times* of April 9 last on this subject, I gave particulars of the performance of these two steamers at equal power and speed. The respective consumptions of coal in the same period were 37 tons for the Tamise and 27 tons for the Seaford. This important difference at once establishes the fact that the coal necessary to propel a warship 1000 miles with Belleville boilers would propel the same warship at the same speed 1370 miles with cylindrical boilers of the same relative economy as those of the Tamise and Seaford. It likewise follows that, if in each case the stokers perform equal work per day, thirty-seven stokers will be required to produce the same power with the Belleville boilers that the cylindrical boilers will give with twenty-seven stokers.

"The experience derived from the working of these steamers regarding the comparative durability of their boilers is of the highest value. Though the passage each way is performed within 3½ hours, or less than 7 hours' working out of 24, the Belleville boilers of the Tamise have, since starting, required constant repairs, several being so extensive as to lay up the steamer for more than a week at a time. The cylindrical boilers of the Seaford, until her unfortunate loss, have required no repair, and the steamer has run since starting without a hitch.

"These vitally important facts, proved by a year's running of these two steamers, could in no way be met by the admiralty or by the supporters of the Belleville boiler, and consequently in the official defence they were not referred to."

These are samples of current adverse criticism on the subject of the adaptation of water-tube boilers for marine service. They do not prove the impossibility that this class of boilers may ultimately supplant the cylindrical type for ship propulsion. They do show, however, that we are not beyond the stage of uncertainty and experiment, and that very much yet remains to be done before the question of water-tube *vs.* cylindrical boilers can be defintely decided.

Oriental Engineering and Shipbuilding.

THE whirl of events seems to have reversed the saying, "westward the star of empire take its way," so far as it applies to the empire of the human mind, which controls the forces of nature and makes them obey human will. The far east, with its vast natural resources of mine, field, and forest, will probably be the scene of the next great chapter in human progress.

At a recent meeting of the Institution of Engineers and Shipbuilders, at Hong Kong, Mr. William C. Jack read a paper which *The Steamship* (Oct.) has reprinted, and in which the primary object of the institution is stated; this purpose is to expand the profession and encourage shipbuilding at Hong Kong, which is regarded as a very favorable location for the industry. Mr. Jack says: "We've got the tools, we've got the men," and in his paper he certainly makes a good showing of other advantages. Whether there are disadvantages that will offset the advantages, we are not able to decide. In the course of the paper some disadvantages are admitted,—for example, the time required at Hong Kong to get steel orders filled. Mr. Jack said:

"Hong Kong has long been famous for its splendid fleet of steam launches, for whose fine models the Chinese carpenters of to-day are indebted to our predecessors, the pioneers of modern shipbuilding in China. These models would do honor to the first yacht builders in the world; still, there will be many . . . . who can remember when the best of them were propelled by a single or double high-pressure engine, and no one can say, when they look at the beautiful compound surface-condensing and triple engines which propel our launches of the present day, that our engineers have been lagging in the march of improvement. A step from the teak wood launch to the steel or composite steamer of modern dimensions came next, and Hong Kong has supplied its neighbors, from Japan to Australia, from the Philippines to India, with specimens of the work that can be turned out here." Speaking from experience, the author alleges that the Hong Kong-built boats belonging to the firm with which he is connected defy comparison as far as hull, engines, and boilers are concerned,—that is to say, they are ahead of the home-built article in finish, workmanship, and durability. To-day Hong Kong is in a position to turn out and equip sea-going steamers in every way equal to the home article, and more in accordance with the requirements of the country and the eastern trade.

The question of price, which, from the

owner's point of view, is of controlling importance, is also treated from the standpoint of the author's personal experience in the shipbuilding and engineering establishment in Hong Kong, of which he is the manager. On this point he says: "We have been able to show, by supplying the government with a light draught gunboat, built in pieces, transported and erected on a river in the interior, that the work could be done more economically than it had been done in France, in the case of boats built for the same service, and this handicapped as we are in Tonkin with customs and other duties. The difference in cost when a boat can be launched and finished at the works may be imagined. It may be put forward that building costs more in France than in England, as it does; but the author may state that the type of boat of which the writer's firm makes a specialty—the stern-wheeler—can be put in the water and finished for less than the F. O. B. price of builders of the same type of steamer in England. Paradoxical as it may appear, it is the low rate of exchange that favors us, as will be seen by the following table of the comparative cost of a steamship of moderate dimensions.

	Cost at Home.	Cost in Hong Kong.
Iron shipbuilders' work	£5889 0 0	£5987 2 0
Carpenters' work	2000 0 0	1576 18 0
Riggers' and smiths' work	573 0 0	551 0 0
Joiners' work	2582 0 0	2116 19 0
Painters' work	387 0 0	293 5 0
Sails, compasses, etc	1037 0 0	1173 16 0
Sundries	362 0 11	345 7 8
Management, etc	459 0 0	918 0 0
Donkey boiler and winch mountings	309 0 0	370 16 0
Engines and boilers	6346 11 9	6348 2 9
Interest on total, 5 per ct.	997 4 7	... .
Interest on total, 10 per ct.	... .	1968 0 7
Totals	£20,941 17 3	£21,648 7 0

"The home prices are taken from the most reliable sources and carefully verified; of course, they may rise or fall according to the demand, but may be taken as a fair average. The deductions or additions thereto are from the author's own experience, and will, he thinks, fairly represent the cost of the same steamship if built in Hong Kong. The wages rate allowed is much higher than actually paid here, but something must be allowed for the inefficiency of the native workmen, who in heavy work cannot be expected to compete, man for man, with their European brethren." In Mr. Jack's opinion the wages rate at Hong Kong would be less than one-third of shipyard wages in England; a considerable economy would also be realized on any materials which could be bought at silver value in the country,—woodwork, for example. Teak and many other kinds of splendid timber can be had at prices which cannot be touched in the home market. Steel, pig, bar-iron, and sundries would of course be augmented by the freight out.

Mr. Jack then proceeds to compute the difference in cost of building a steam-ship respectively in Hong Kong and in a British shipyard, and finds the difference to be 13s. 10d. per gross ton, which difference, he alleges, would be more than swallowed up by the voyage out, to say nothing of the fact that, on arrival, there are further expenses and delays in overhauling, paying off and sending home crews, and often for docking. Taking all the expenses into account, as stated by the author, the ship built at Hong Kong could be delivered to its owner in Chinese waters, with a fair profit to the builder at less cost than that of a similar ship built in England.

The Lake Ship-building Industry.

THE ENGINEER (London, Oct. 12) makes this the subject of an editorial, in which it alleges that the completion and opening of the Canadian ship canal at Sault St. Marie will render the tonnage of the American lake marine obsolete, and predicts that the supply of vessels adapted to the new conditions will give business to the western shipyards for some time to come.

The argument is based upon the facts that the canal on the American side has hitherto afforded passage only for ships of from 14 to 15 ft. draught, while the new canal affords a draught of 20 ft., and that, as a consequence of the understanding between the governments of Canada and the United States whereby both canals may be used on the same terms by ships of both countries, there will be brought into existence a fleet of vessels which can use only the deeper waterway. The effec of this upon ship-building and ship-owning interests on the lakes will, in the opinion of *The Engineer*, be most important and far-reaching,

The way in which the former draught limit has influenced the design and construction of ships on the lakes is thus explained. "With one dimension,—*viz.*, depth, a constant quantity,—it necessarily followed that all increase in the tonnages and carrying capacities of the lake steamers could only be effected by augmenting the other two dimensions of length and breadth. This has been carried out to such an extent that it is no uncommon thing to come across steamers having such abnormal proportions as twenty and twenty-one depths in length to main deck. This feature, combined with the enormously wide and numerous cargo hatchways in the steel topsides, necessarily tended to produce structural weakness, so that, in several cases wherein adequate compensation for excessive proportions and large openings in decks and sides had not been provided, signs of straining were evinced; and two such vessels were lost under grave suspicions of having broken in two. For many years, then, the cry has gone up, from Buffalo to Duluth, for a deeper channel way.

"But deficiency in depth of water has not been limited to the Sault Sainte Marie canal. The small Lake St. Clair and the river St. Clair, which joins it to Lake Huron—the whole forming, with the Detroit river, the junction between Lakes Huron and Erie—have also been hindrances to deep-water navigation. But, as the fall between the two lakes is only about 8 ft., and the channel admits of dredging, the conditions to be found at that part of the large fresh-water system are now at least as good as have been provided at the Sainte Marie river. It is in the river and harbors on the United States side of the lakes that the most serious hindrance to the further deepening of the draughts of lake vessels will be found. The rivers Chicago and Calumet at Chicago, the Cayuga river at Cleveland, and the creeks and channels at Buffalo, which in effect constitute the harbors at these important cities, have nowhere more than about 15 ft. of water. As all the wharves, storehouses, granaries, &c., for the loading and discharging of vessels are on these shallow streams, it is evident that they too must be dredged deeper, if they are to be of use for vessels drawing as much as 20 ft. But to dredge them deeper would be to weaken the foundation of the huge buildings on their banks, and bring them to the ground. Competition will, soon end their usefulness, for the deep-draught, large-carrying steamers will drive them out of the struggle, and the narrow, shallow, muddy, and malodorous rivers at Chicago will in the end be doubtless covered over and hidden as effectually as the Fleet and other tributaries to the Thames which once flowed openly through the city of London."

The effect upon hitherto unavailable and unprofitable sites for lake ports is open to conjecture, but our contemporary thinks that the fact that a firm in Detroit—a city more than 1000 miles inland—has already contracted to build three steam vessels for navigating Russian rivers, and that from this point ships may be sent through the canal and across the ocean to Europe, ought to set English shipbuilders to thinking. There have been other indications of commercial apprhension in the British press of late. One will be found in our department of "Industrial Sociology."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*1894. The Great Modern Transatlantic Steamships. Ill. Samuel Ward Stanton (Reviewing progress in construction of oceam steamers from 1881 to 1895). Eng Mag-Dec. 4500 w.

1915. The Launch of the Armored Cruiser Brooklyn Ill. (Brief description calling attention to new features). Sci Am-Oct. 12. 500 w.

*1918. Launch of H. M. S. Venus. Ill. (A detailed description of a second-class protected cruiser for the British government. Cuts of steering engine and gears). Steamship-Oct. 1600 w.

*1919. Engineering and Ship-building in the

Far East. William C. Jack (Paper read at meeting of Inst. of Engineers and Shipbuilders at Hong Kong. Setting forth the economic value of this institution in the Far East). Steamship-Oct. 1700 w.

*1920. Automatic Governor for Marine Engines. Ill. (Patented by Thomas Barnfather and Charles Kübler. Intended to be used as a regulator of the steam supplied in such a manner as to prevent "racing" of the engines). Steamship-Oct. 1200 w.

1968. Kerosene Yachts. J. H. Killey (A description of a kerosene yacht on Hamilton Bay, and general discussion of kerosene motors for yachts and launches). Can Eng-Oct. 800 w.

2007. The Invention of the Steamboat (From *United Opinion*. A letter from Capt. Samuel Morey, who propelled a vessel by steam some years before Robert Fulton and his associates, with brief account of his work). Eng-Oct. 12. 1500 w.

*2075. The Waste and Supply of Shipping (Statistics compiled from Lloyd's Registry presenting the debit and credit side of the shipping industry). Engng-Oct. 11. 1200 w.

*2076. Water-tube Boilers for Marine Use. James Howden (A critical examination of the advantages claimed for water-tube boilers in which the time named for getting up steam is held to be greatly over stated in favor of water tube boilers and a general exaggeration of the advantages is alleged). Engng-Oct. 11. 4500 w.

*2077. Belleville Boilers and the British Admiralty. Argus (A further criticism of the Belleville boiler in which the British Admiralty is charged with having adopted the boiler before they had carried out a single experiment with it, and severely denounced for its action in the matter). Engng-Oct. 11. 4500 w.

*2082. Water Supply on Board Ship (How a full water supply may be assured by the use of evaporators, with illustration and description of a distilling apparatus for this purpose). Eng, Lond-Oct. 11. 1200 w.

*2083. 6000-Ton Depositing Dock for Barcelona (Illustrated description). Eng, Lond-Oct. 11. 1000 w.

*2084. Shipbuilding on the American Lakes (Discusses the inevitable effect of the opening of the Canadian ship canal at Sault Sainte Marie; existing tonnage will become obsolete, and shipbuilders and marine engineers will reap the benefit of replacing it with ships of larger capacity). Eng, Lond-Oct. 11. 1500 w.

*2086. The Propelling Machinery of the Samoyed. Ill. (The ship was completed within three months from date of order. A set of indicator diagrams and a cyclogram presented in this article show that, notwithstanding this unusually rapid construction, her performance is very satisfactory). Eng, Lond-Oct. 11. 1000 w.

*2088. Marine Boilers (A criticism upon water-tube boilers for marine use exemplified by the behavior of the boiler on the new American liner, Paris). Eng, Lond-Oct. 11. 2200 w.

*2089. An Amphibious Boat (An illustrated description of a very curious boat, or railway car, or, better, an amphibian combination of car and boat, self-propelling for both purposes, which plies on two lakes near Copenhagen, and crosses an isthmus, 1100 ft. in width, each trip, and which since July 15th has made six trips daily, and carried 20,000 passengers). Eng, Lond-Oct. 11. 1000 w.

*2110. The Revival in Shipbuilding (Statistics showing a marked improvement during the past three months). Trans-Oct. 11. 900 w.

*2142 Marine Etiquette. A. Oscar Klaussmann (Translated from "Ueber Land und Meer." Sketch of international marine etiquette and its expense). Chau-Nov. 2200 w.

*2168. Depositing Dock at Barcelona (Illustrated description). Engng-Oct. 18. 800 w.

*2171. The America Cup (A discussion of the late yacht race between Valkyrie and Defender from a professional point of view. The Herreshoffs are given great credit as original designers, but English sail-makers are considered still superior to American). Engng Oct. 18. 2500 w.

*2172. The Strength of Cylinders. J. C. Spence (A theoretical discussion with an editorial criticism). Engng-Oct. 18. 3600 w.

†2192. Description of the Finlayson Marine Pipe Boiler. Arthur E. Blackwood (This boiler is a new claimant for public favor which has come into notice during the past year, and which has distinctive features worthy of study). Eng Soc of School of Prac Sci-No. 8. 1000 w.

†2271. Quick Transit between New York and London. Austin Corbin (Favoring the shortest possible route, which it claims would be from Fort Pond Bay, on the north side of Long Island, six miles from its most eastern point, to Milford, the most westerly port of Wales. Tables of comparative routes are given and time calculated. The advantages are shown, and its national importance explained). N Amer Rev-Nov. 5400 w.

2304. Stopping, Steering and Resistance of Floating Vessels. Joseph R. Oldham (Abstract of a report of a committee appointed to investigate the effect of reversing the screw of a vessel upon the action of the rudder). Sci Am Sup-Nov. 2. 2700 w.

2392. The Use of Current Meters in Marine Observations (Deals with difficulties met in the use of current meters in a seaway during a survey of the Gulf of St. Lawrence, and the method and appliances used in surmounting the difficulties. A very interesting paper on an important subject). Eng News-Oct. 31. 900 w.

2427. Engine of the Steam Yacht "Free Lance" (General features of design and arrangement). Am Mach-Nov. 7. 600 w.

2457. Corn-Pith Cellulose for Warships (A description of tests made by the United States Navy Dept. with corn stalk pith cellulose as a substitute for cocoa fibre cellulose for closing holes and excluding water from shot holes in warships). Eng News-Nov. 7. 900 w.

MECHANICAL ENGINEERING

Steam Pipes and Pipe Joints for Marine Use.

In line with the subject of winding steam pipes and the testing of wound pipes, treated in this department for October, is the following abstract of an unsigned article on marine steam pipes and the making of joints therein, in *The Iron Age* (Oct. 24).

The author thinks the success of the recent introduction of steel pipes is yet problematical, although they appear, so far, to answer very well. Time is needed to develop the defects which, he thinks, may exist, and which may yet reëstablish the superiority of copper for this purpose. The difficulty of carrying high steam pressures in copper pipes is not ignored by this writer, but he thinks that, while attention is bestowed upon strengthening copper pipes, study should also be directed to the improvement of joints, which, he claims, are commonly faulty; and he follows this with good practical directions for making permanently tight joints.

The flanges of copper pipes are usually of composition, and are secured by brazing. Brazed joints frequently give trouble, as ofttimes the work is so carelessly done as to burn the copper and destroy its tenacity. Indeed, the brazing on of a large flange can be intrusted only to the most skilful of coppersmiths, and is always attended by risk and uncertainty. It is always impossible to know exactly the extent of contact of the spelter under the boss of the flange, and it has become the best practice to counterbore the flange face heavily and to turn the pipe end completely into this recess, facing the end off to the facing of the flange surface. This adds greatly to the strength of the connection as well as to the tightness of the joint, and should always be carefully looked to, as the difference in expansion of the composition and the copper always tends to separate the flange from the pipe.

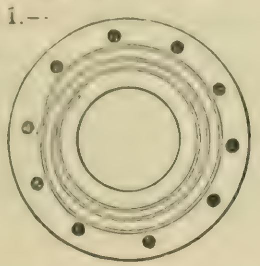
For making good joints the flanges must be, first of all, faced off. Rough and uneven surfaces, or those with surfaces warped or curved, will not allow a good joint to be made on them. After facing, the next point to keep in mind is that, the thinner the interposed material, the better for the durability of the joint. The day of thick gaskets has long since passed. In fact. there is no theoretical reason for any gasket whatever between faced flanges, but, in practice, unless the surfaces are ground together, there are little inequalities which prevent an absolutely perfect contact, and necessitate an elastic or pliable filling.

For standing or permanent lines of piping which do not have to be taken down for any work on adjacent machinery the very best joint is made with red lead and iron borings. The borings must be very fine, sifted through a fine wire gauze sieve, and then mixed with red lead putty, until the color is black and the consistency such as will allow it to be broken without bending. The surface of the flanges should be scored with one or more continuous rings, as shown on the sketch of flanges, and the putty applied in as even and thin a layer as possible. The joint is then set up as tight as the bolts will safely stand, and the putty is baked by putting a blank temporary flange on the open end of the pipe and turning on a very little steam. This baking process should be done with every joint before the next one is made, and the resultant satisfaction will amply pay for the time and trouble taken.

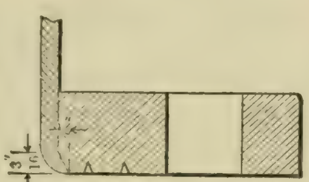
For other pipes, which are of necessity removed occasionally, a different joint is recommended. A sheet gum gasket used to be the only kind used, its ease of fitting and applying giving it many advantages; but the ordinary sheet gum, pure or cloth inserted, will not stand the tests of high pressures and temperatures, and, while there are many modifications of it admixed with graphite and other substances, they all have the fault of softening under heat and requiring the going over of all the bolts of the flange after steam has been applied to the pipe. Where gum for any reason must be used, the kind to apply is the specially oxidized, which will not strip from the insertion. Better than gum, however, is the wire gauze and asbestos material now on the market, wherein strands of copper wire are first woven about with a web of long fiber asbestos, these wires then being woven into a wire cloth and the insterstices filled with a rubber paint. This should be used in the thinnest form, nothing thicker than $\frac{1}{16}$-in., for the best results. It is an almost perfect packing, and could be improved only by having the wires woven in spiral mesh instead of square. It is far better than the old wire gauze and red lead joint, as it is absolutely evenly filled, while the other joint frequently failed through having the lead lumpy or gritty and uneven. The best kind of joint can be made with simply soft copper wire alone. It is more difficult to apply, especially where the flanges are vertical, but its trial will be well repaid. The wire must be soft and uniform; the winding can be done on any mandrel, and the turns overlapped or spread out like a spiral spring compressed to one plane. The ends should be secured to their adjacent helix by a touch of solder only on the sides, and not where it will come in contact with the flange. Single and separate rings are just as good, but harder to space properly and hold in position before setting up, and the style illustrated in Fig. 1 is better for this reason. When hot, the joint is tightened by the greater expansion of the flanges and wire over that of the connecting iron or steel bolts. With this or the wire woven material above all, the smaller joints can be made absolutely tight, and the permanent joints made and baked as described can be relied on to stand for years without a weep.

Soft Copper Wire Joint.

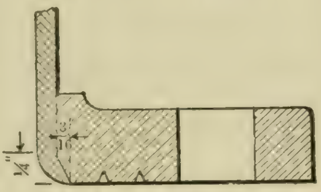
Fig. 1.—



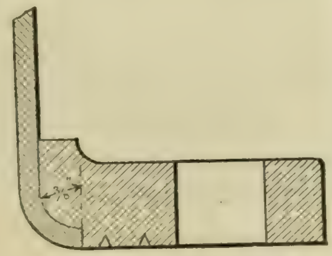
Flanges for Water Pipes and Exhaust Pipes.



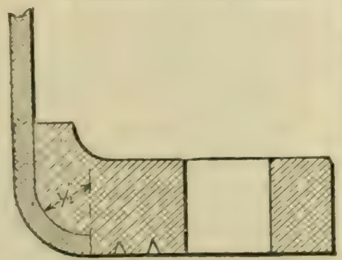
4½ inches and under.



5 inches and 5½ inches,

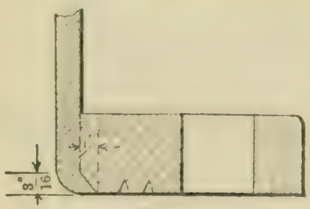


6 inches to 11½ inches.

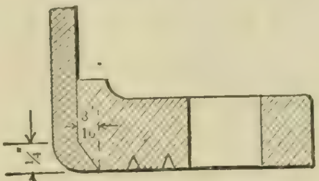


12 inches and up.

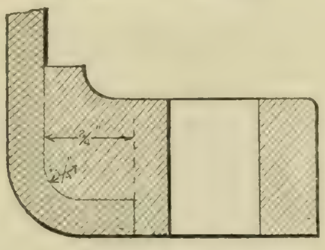
Flanges for Steam Pipes and Feed Pipes.



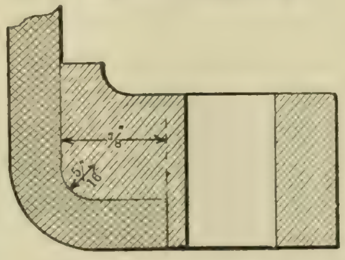
4½ inches and under.



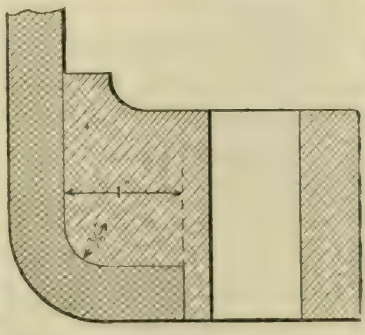
5 inches and 5½ inches



6 inches to 11½ inches.



12 inches to 17½ inches.



18 inches and over.

Figs. 2 *to* 9.—*Manner of Turning Over the Pipe Ends*

It is a common occurrence to have leaks appear around the flange bolts while the flange joint is tight. This should not be, as it shows that the part outlying the line of bolts is the best part of the joint. This fault is as bad as a leaky gasket, sometimes, owing to the difficulty in grummetting bolts in many situations. The whole effective joint should be embraced in the surface between the bolts and the pipe orifice; there is no more necessity for a very wide bearing than in the case of a seat for a conical valve.

Electric Welding—Another New Process.

QUOTING *L'Industrie Electrique*, the *Western Electrician* (Sept. 28) gives a description of the latest new process of electric welding, devised by Dr. Zerener, pointing out distinctions between the four principal processes now known. The following abstract of the article presents the main facts relating to the several processes.

Prof. Thomson's method depends upon the direct transformation of electric energy into heat energy at the point where the union is to take place. Alternate currents are used. The high temperature attained, because of the resistance offered, renders the metal soft and malleable, but a generator of high power is required, while the secondary current used must be capable of great intensity with very low voltage. Iron wires, cables, bars, rails, etc., may be welded by this process, but plates of considerable surface cannot be so well manipulated, because of the impossibility of covering the necessary space with the currents of the proper strength to produce the heat required.

In the process of M. de Bernardos the heat of a voltaic arc is utilized upon the article to be manipulated, this last being brought between the arc, which is the positive pole, and the negative pole, which is of carbon, in case the object is of iron or steel, and the reverse contacts being made for other metals. The current used is a continuous one, and may reach 1000 amperes.

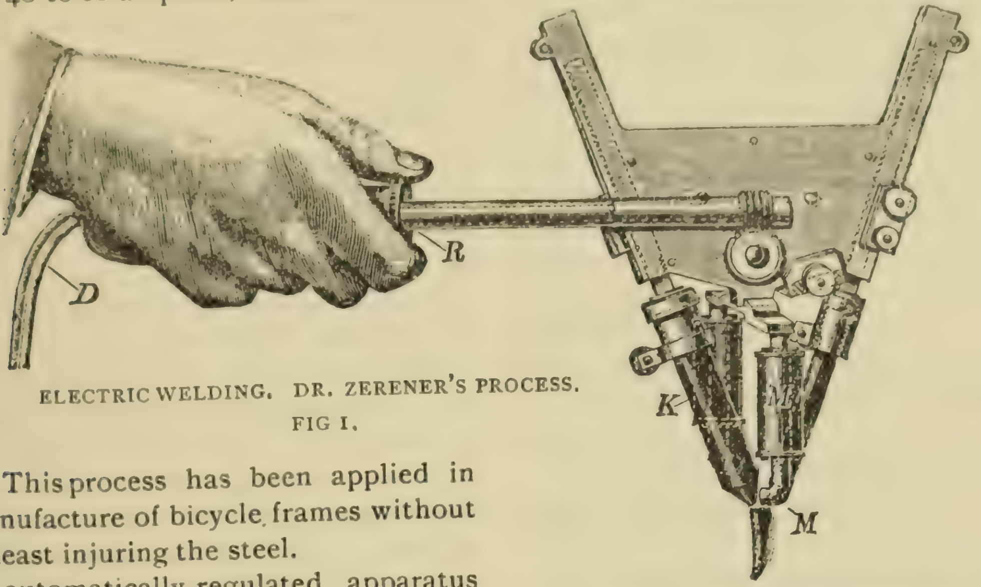
In the process of Lagrange and Hoho the voltaic arc is not directly utilized, but heat is developed by resistance to current. The resistance is produced by a hydrogen medium surrounding the object to be treated, which is in a bath of water connected with the opposite electrode. This process is evidently unavailable for plane surfaces.

The limitations of application and the high currents required in each of these processes seriously impair their general usefulness, and from these objections it is claimed that the Zerener process is exempt. In this process the heat of the arc is utilized, as in the Bernardos system, but the two poles are two carbons, whereas in the Bernardos system the article becomes one of them. The distance secured by adjusting these permits a greater range of surface and regulates the intensity of the current, and the consumption of energy as well, while the metal is not consumed as part of the arc. An ordinary arc cannot be well utilized for heating purposes, without very closely approaching the object treated. Dr. Zerener has overcome this difficulty by arranging the two carbons in "V" shape, and submitting the arc to the action of a magnetic field developed by an electro-magnet, which forces the arc downward toward the angle of the "V." In these conditions the arc takes the form of a dart. This projected flame has a temperature nearly equal to that of the arc proper, and is readily available for welding.

In Fig. 1 is shown an apparatus designed for hand regulation, although larger ones have been made for automatic regulation. It is said that the weight of this apparatus is not over one kilogram. The arc is regulated by hand by turning the thumb-screw, *R*, forward or back, thus changing the length of the arc to suit the requirements of the case.

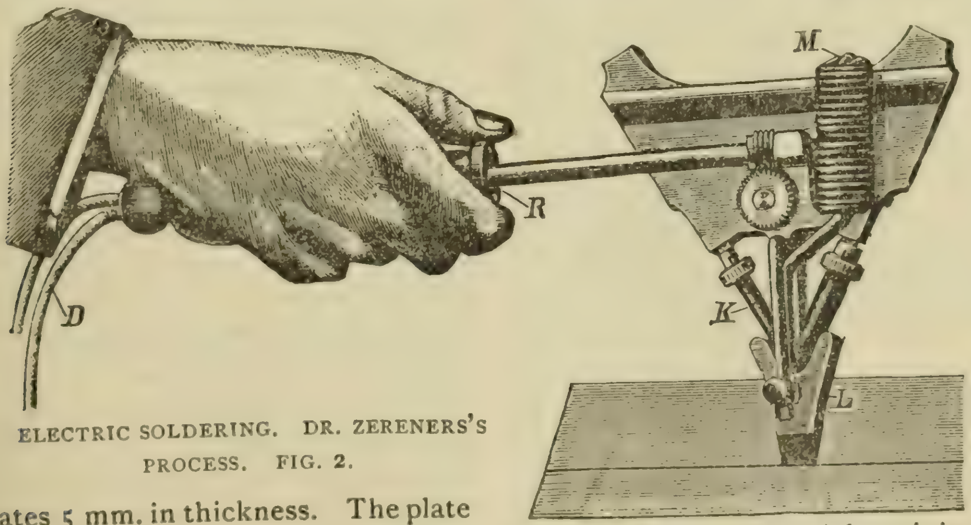
The spools, *M*, of the electro-magnet are branched in series with the arc, enabling the operator to obtain a pointed flame at will,—a flame of high temperature,—which can be directed immediately on the point of the metal where the junction is to be made. The wires, *D*, shown below the wrist of the operator, lead to the carbons as in an ordinary arc lamp. The apparatus is very effective with a minimum current of 15 amperes at 40 volts, and, when necessary, a maximum of 2400 watts may be reached. The apparatus may be used for welding or brazing small pieces of iron, copper, silver, etc., without the intervention of any preparation.

When the current required for brazing reaches 40 to 60 amperes, a flux of borax is used. This process has been applied in the manufacture of bicycle frames without in the least injuring the steel.



ELECTRIC WELDING. DR. ZERENER'S PROCESS. FIG I.

The automatically-regulated apparatus is built upon the same general principle. Constant potential current is used; the solenoid producing the field is excited in derivation with a current of 15 amperes. The arc absorbs 100 to 200 amperes with a difference of potential of 70 volts. This model is used for welding iron, and will weld plates 5 mm. in thickness. The plate is placed upon a piece of iron, the two lips to be welded being separated about 2 mm. The apparatus being thus disposed, the extremities of the carbons are held a short distance from the plate. With the aid of a spring support, a very feeble effort on the part of the workman suffices to graduate the distance from the point to be acted upon. Small pieces of soft iron are melted between the plates to be joined, and the junction is hammered smartly during the cooling process. The work is thus accomplished in sections of about 2 c m.



ELECTRIC SOLDERING. DR. ZERENERS'S PROCESS. FIG. 2.

The employment of an arc between two carbons permits limitation and regulation of the consumption of current. An arc of 3 amperes and one of 200 amperes have the same temperature; it is only the quantity of heat disengaged that varies. According to the needs of the case the intensity of the current may be regulated,—a regulation which covers from the minimum of 3 amperes to a maximum of 200 amperes. The cost of the apparatus is less than that for either of the other methods. No accumulator is needed, and the current of an ordinary lighting or power plant may be used. Fig. 2 illustrates an electrically-heated soldering iron, to the copper bolt, *K*, of which the current is applied.

The Horseless Carriage.

MR. PAYSON BURLEIGH, who seems to have given attention to the subject, gives some points to inventors of horseless vehicles in *The Age of Steel* (Oct. 12). First, it will be necessary to have steering gear by which such vehicles can be guided with no greater exertion than is now required to drive a horse. "Under the very best conditions," says Mr. Burleigh, "the driver will have to keep a closer watch than in driving a horse, because, when a horse is used, the business of guiding the vehicle is divided between two intelligences, that of the man and of the beast; and, when he is well trained, a good deal of it is left to the intelligence of the animal. It will be some time before the inanimate carriage receives the training which will allow it to be driven with a loose rein anywhere except on a tramway.

"The horse follows the crooks of a country road, but then the training of the 'motorcycle' (horrid name) will inevitably straighten out the crooks in the country road, and afford long ranges of straight tracks. The horse never blindly runs plump into another vehicle in the city streets. A mere touch of the rein, simply as a suggestion, is sometimes given, but a well-trained horse is often more capable of guiding himself than the best driver is capable of directing his course. In a dark night on a dangerous road—like some of those which skirt the sides of Californian mountains, where a misstep means a headlong plunge over a precipice—the human perceives that impertinence is too risky, and allows the noble steed to go as he will.

"When one takes out a self-propeller for a spin on the road, however, he has to find, not only the intelligence for the direction of his course, but also all the power needed to keep it or to change it. It may seem, at the first glance, that very little power is needed for this purpose, but a little reflection will show that there must be a constant expenditure of force, even to keep a straight course, because the resistance to one wheel is scarcely ever just equal to the resistance against the other, and just so much as it is greater, that much must be borne by some other power. If a stone, or a depth of sand, or anything else, obstructs the passage of one of the guiding-wheels, there is a tendency to push that wheel back,—or something equivalent to that,—and this tendency must be overcome, or the vehicle will deviate from its course."

An argument is then made to show that steering a four-wheeled vehicle by the leading wheels will permit shorter turning and consume less power than steering by the rear wheels.

The feature deemed next in importance is the brake mechanism, which must be certain in its action and readily manageable. If this class of vehicle is to become widely popular (and Mr. Burleigh thinks this seems to be assured), "it must be so easily managed that a lady can take it out to go for an airing with no more trepidation or anxiety about steering it than she feels in handling the reins."

Mechanical and Unmechanical Devices.

THESE terms, used very vaguely by mechanics in general, are made the subject of an article by Mr. Frank Richards in *American Machinist* (Oct. 24), and an attempt is made to define them. Some devices in common use in shops are also criticised as unmechanical, and lines of improvement are indicated. Mr. Richards says:

"The most mechanical device or system is that which, all things considered, is best adapted to the accomplishment of the proposed result. A very common expression of condemnation employed by practical mechanics regarding devices which challenge their judgment is that they are unmechanical, and we usually find that the idea meant to be conveyed is that they are not the best that could have been employed for the purpose. There are mechanics who regard some devices as more mechanical than others, independently of the place and mode of their employment. Mechanics generally dearly love toothed gearing, and are slow to condemn its use anywhere as unmechanical; but gears may be out of place sometimes, just as much as toggle joints or sprocket wheels and chains may be out of place, and therefore may be unmechanical. The mechanical device is usually the simple device, but it is not always and necessarily true that the simplest is the most mechanical. Simplicity in everything mechanical can scarcely be overrated, but the lasting or slow-wearing property may be of first importance in some cases, and this may be sometimes promoted by a little more complexity of device. If it can be shown that serious and constant wear is involved in the employment of a certain mechanism, and that this wear might be mostly avoided by the employment of another device of the same, or but slightly-enhanced, cost and complexity, then the first must be condemned as the unmechanical one. The term mechanical or unmechanical can never be employed for sentimental or traditional reasons, but only in view of results accomplished. Nothing, if it will work at all, is, unmechanical, until a better device can be found to supersede it. Fault-finding has its only justification in the suggestion of something better."

Designing Machines.

AN editorial in *American Machinist* (Sept. 12) says some sensible things on the subject of designing machines. It attributes " much of the crudeness apparent in machine designs . . . . to the fact that the art of designing in iron is yet in its early and formative stages," which sounds rather queerly when we reflect that the use of iron dates back to a prehistoric period. That "there are few who clearly see what is appropriate and what is inappropriate " may be admitted. Our contemporary thinks only two styles yet evolved "that deserve to be perpetuated. The hollow pedestal may be taken as the "type of one of these and the I-beam of the other. A machine having all its parts in one or the other of these will be harmonious in its style, though it may be illy-proportioned and lack grace of form ; but a design that mixes the two in one machine can be but a mongrel, no matter how meritorious it may be in other respects." The article is, in the main, a criticism of the impropriety of applying architectural ideas to machine designing, and appears to have been called forth by an absurd design for a type writing machine recently put upon the market, which design, an advertising circular states, was executed by an architect of some note in connection with one of the buildings erected at the late World's Fair at Chicago. The secret of machine designing is almost unveiled in the following quotation.

" There are a number of frightfully ugly typewriters on the market, but there are also some very neat ones, and in every case the ones that are most pleasing in appearance will be found to have frames designed in harmony with the material of which they are made and for the evident and sole purpose of effectively supporting the working parts of the machine in their proper positions."

Adaptation to the exact working requirements without excess of material at any point is the secret of good machine designing. Parts designed to have greatest strength when applied to a given purpose with the minimum of material are nearly always graceful in form. The hollow pedestal and the I-beam spoken of above are examples, if designed on the principle enunciated. Simmered down, we find this principle to be maximum utility wedded to economy of material.

In nature,—as in the trunk of a tree, with its graceful curves outward toward the roots and its upward taper, or in the shell of a bird's egg—this principle is carried out to the utmost extent.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Technical Journals—See Introductory.

The Machine Shop.

2129. The Construction of the Teeth of Gear Patterns. Ill. Isaac Whitehead (Discussion of a method proposed by Mr. Dingey and a description of another method). Am Mach-Oct. 17. 1300 w.

2130. Conference on Unification of Methods of Testing Materials of Construction. Gus. C

Henning (Progress in the work of the committee—yet far from conclusion—is reported. Questions discussed and conditions proposed are given). Am Mach-Oct. 17. 1500 w.

†2183. Vice-Work. G. M. Campbell (The subject is treated in a broad manner as including all operations not performed by machine tools. Illustrations of tools for clipping, filing, scraping, polishing, etc., with illustrated description of appliances for holding work, etc., are given). Eng Soc of School of Prac Sci–No. 8. 6000 w.

†2188. The Cleaning and Annealing of Castings. H. L. McKinnon (Describes various processes for improving the appearance and quality of iron castings, such as pickling, annealing, rolling, etc.) Eng Soc of School of Prac Sci–No. 8. 2300 w.

†2190. Hardening and Tempering Steel. E. F. Shipe (Discussed wholly from the standpoint of the workman in the shop, and therefore of practical importance to all who have hardening and tempering to do. The work of hardening and tempering is divided into three classes, viz., tools, etc., in which only a part is to be hardened and tempered, those which are hardened all over, and dies, tools and parts of machines required to be as hard as possible. Each class is treated seriatim and practical suggestions are given). Eng Soc of School of Prac Sci–No. 8. 3000 w.

†2191. Gear Cutting. H. V. Haight (The different styles of gears are first considered and they are divided into four classes, and this is followed by descriptions of methods calculated to secure the highest degree of perfection in cut gears; the text illustrated by numerous diagrams). Eng Soc of School of Prac Sci–No. 8. 3300 w.

2283. Some Historical Notes Relative to the Invention and Development of the "Slide Rest." Ill. W. F. Durfee (The author has here brought together a great deal of interesting information). Am Mach-Oct. 31. 2500 w.

2284. Design for a V-Threading Tool—Lead Lapping. A. H. Cleaves (The tool described is Intended for the performance of small work on a large lathe in cases where a smaller lathe is not at hand). Am Mach-Oct. 31. 1800 w.

2331. Modern Milling Machines. Ill. (A general review of the principal milling machines now in use, with notes of individual merits and special adaptations for different kinds of work). Mach–Nov. 3600 w.

2332. Some Notes on Upsetting Steel. Boyd Harriman (Practical observations by an expert tool-dresser, containing valuable hints). Mach–Nov. 1000 w.

2333. Measuring Angular Work. J. T. Giddings (Discusses pleasantly and profitably, instruments and methods for the purpose named). Mach–Nov. 1300 w.

2334. Steel Riveted Steam Pipe. James Anderson (Criticises the application of boiler methods to the making of this class of pipes as being faulty, and then proceeds to describe and illustrate the proper method. A table is appended, giving port area, port width, and steam pipe diameter for various piston speeds and steam velocities). Power–Nov. 500 w.

*2343. Rivets and Riveting. G. R. Bale (Discusses material of rivets, different forms of rivets, tests both for ductility and bending, proportions of rivet heads tabulated for different sizes and machine riveting versus hand riveting) Prac Eng-Oct. 25. 1500 w.

*2360. A Chuck for Screwing in Stay Bolts (Describes and illustrates an ingenious and useful implement invented by Mr. L. Bartlett, Master Mechanic of Missouri Pacific R. R., and now used in shops under his charge. It is used in connection with a steam or air-driven motor). Nat Car & Loc Build–Nov. 600 w.

2428. Reamers—Countershaft—Hangers—Projection of Drawings—Monkey Wrenches. Oberlin Smith (Discussion of practical questions relating to the appliances named). Am Mach–Nov. 7. 2000 w.

2429. Sectional Dies. J. L. Lucas (The advantages of sectional dies, if the dies be of large size, or of difficult shape; construction of compound dies illustrated by a diagram). Am Mach–Nov. 7. 800 w.

Steam Engineering.

1967. Steam Boiler Explosions. A. E. Edkins (General considerations and an account of personal experiments, inspection, etc.) Can Eng–Oct. 5000 w.

*1974. Boilers and Feed-Waters (Editorial. General discussion of principles, and an argument favoring the pumping of feed-water into steam space, instead of below the water line, as resulting in greater durability and lessening needed repairs). Eng Lond–Oct. 4. 1900 w.

2000. The Tubular Boiler (A good boiler to invest in when properly designed and carefully made and set up). Bos Jour Com–Oct. 12. 1000 w.

2008. Effect of Fire on Boiler Plates (In favor of water-tube boilers. Experiments of Dr. A. C. Kirk). From the *Indian Textile Journal*. Eng–Oct. 12. 1300 w.

*2028. Boiler Explosions Ill. W. H. Fowler (Paper read before the Inst. of Civ. Eng. The subject dealt with in its broad engineering aspect, with brief reference to old theories). Prac Eng–Oct. 4. Serial. 1st part. 3300 w.

*2052. On Condenser and Receiver Drop. A. C. Elliott (Mathematical and thermo-dynamic discussion, the object of the paper being (a) to point out in the first place, why condenser and receiver drops are necessary; (b) to inquire with regard to certain economical considerations what amount of drop should be allowed as a minimum; (c) to discover the effect of drop on the quality of the steam subjected to it; (d) to find whether in a particular cylinder any part of the power lost by receiver drop is recovered in the next cylinder, and if so, how much; and (e) to develop the thermo-dynamical equations for compound engines of two or more stages, taking account of drop). Engng Oct 4. 2500 w.

*2059. Continuously Registering the Performance of Winding Engines, with Observations on Steam Expansion M. Griot (From a communication to the Société de l'Industrie Mineral, Saint Etienne. An exceedingly able paper, naming conditions to be fulfilled by expansion in winding engines, with experimental methods of studying these conditions, and practical applications of principles to the fulfillment of the conditions). Col Guard-Oct. 4. 6400 w.

2127. Cylinder Oils and Oil Experts. W. E. Crane (Qualities needed in cylinder oils, and experiences with various kinds, good and bad). Am Mach-Oct. 17. 1100 w.

†2186. Hirn's Analysis of Heat Distribution in the Cylinder of a Steam Engine Edgar J. Laschinger (This analysis is discussed in relation to important additions to Hirn's investigations made by Zeuner, Major English, and Mr. Bryan Donkin, and with reference to increasing economy of steam in practice). Eng Soc of School of Prac Sci-No. 8. 2500 w.

2329. Angularity of Connecting Rods. Theo. H. Scheffler, Jr. (An adaptation of Zeuner's well-known diagram whereby the angularity of the connecting rod is taken into account in locating the point of cut-off). Mach-Nov. 400 w.

2330. The Inertia Governor. J. Begtrup (An analysis of the action of this class of governors and a discussion of the mechanical principles involved in their operation). Mach-Nov. 2400 w.

2335. A New Method of Heat Transmission (Describes an interesting new departure in the construction of steam boilers, in which instead of heating the steam generating water directly by application of the heated gases of combustion applied to the water containing compartments, the gases of combustion are utilized in superheating steam in tubes which run into the water space and thus convey heat to the water. The construction of the boiler is illustrated by a diagram and an account of tests is also given). Power-Nov. 2500 w.

2336. Bursting Strains of Fly Wheels (Principles involved are illustrated by diagrams and formulæ for the easy computation of the strains are supplied). Power-Nov. 1000 w.

*2400. A New Theory of the Strength of Boilers. J. C. Spence (Mr. Spence says that "starting from the hypothesis that the shell of a boiler in transmitting pressure to its ends acts as a hollow cylindrical beam which must be treated as a continuous whole and not as a set of disconnected staves, my own conclusions are that the bending moment in any direction at any point in the beam is balanced by an equal bending movement acting at the same point but in the opposite direction ; that the pressure which is transmitted to the ends is transmitted by a series of shearing stresses, increasing from nothing at the center to a maximum value at each end ; that the amount that can be so transmitted is limited by the resistance of the shell plate to shearing through at the ends"). Eng Rev, Lond-Oct. 21. 2400 w.

2431. Some Threshing Incidents (The statements as to the altogether remarkable carelessness, recklessness, ignorance and obstinacy of the agricultural population in Minnesota and Dakota are almost incredible. The experiences of an insurance inspector among these people are recounted). Sta Eng-Nov. 1300 w.

Miscellany.

*1889. Aim and Scope of Schools of Mechanical Engineering. R. H. Thurston. Eng Mag-Dec. 2000 w.

*1891. Opposition to Inventions. William C. Dodge (Showing by numerous examples the disposition to discourage inventors). Eng Mag-Dec. 3000 w.

*1892. The Value of Manual Training Schools. Ill. A. E. Outerbridge, Jr. (Discussed in the light of methods employed and results achieved at Philadelphia). Eng Mag-Dec. 2300 w.

*1895. The Bearing of Machine-Shop Experience. Charles E. Emery (Discussing the question of how far and in what order instruction at technical schools should embody practical York). Eng Mag-Dec. 2400 w.

1914. Welding and Forging Steel. Ill. (The illustrations were taken from the plant of the Benjamin Atha and Illingworth Co., Harrison, N. J. Descriptive of process). Sci Am-Oct. 12. 900 w.

1956. Strength of Boilers (The best shape to withstand pressure is probably the sphere ; the next best the cylinder. The strength depends upon the tensile strength of the iron or steel, the thickness of the shell, the strength of the riveted joints, and the diameter of the boiler. How to figure the strength). Lord's Mag-Oct. 2000 w.

1957. Wastes of Heat (The causes of waste considered). Lord's Mag-Oct. 2000 w.

*1984. The Manufacture of Costly Steel Instruments. Thomas Morris (Abstract of paper read before the South Staffordshire Inst. of Iron & Steel Works Managers. The extent to which labor adds to the value of crude material in its conversion into articles in common use is most strikingly shown in this interesting paper.) Ir & Coal Tr Rev-Oct. 4. 4000 w.

1993. India Makes a Step in the Right Direction (An exhaustive article regarding recent changes in the patent laws of India. It is proposed to make radical changes in the old law which will prove of interest to inventors and patent agents). Inv Age-Oct. 2500 w.

2001. Hydraulic Elevators (A test to ascertain their economy, with table of general results). Bos Jour Com-Oct. 12. 800 w.

*2033. Deflections and Strains in a Flexible Ring Under Load. William H. Searles (Flexible ring of uniform section standing. The following inquiries are answered mathematically by formulas deduced from known data. What load will be required to produce a given depression ? What will be the horizontal extension of the ring under the same load ? What is the relation between the vertical and horizontal displacements? What is the general relation between loads and vertical depressions? What are the principal moments of resistance at the side and top ? What is the position of the section of no moment at any period of deflection ? What is the radius of curvature at the side or at the top under any condition of load or depression, and at what point of depression does the radius of curvature become infinite? Again the same questions arise if we suppose the load to be replaced by a vertical pull, changing the ring from a roller into a link). Jour Asso of Eng Soc-Sept. 3200 w.

*2049. Butter Manufacture. Ill. (Description of new Swedish power churn which separates the butter from the cream almost instantaneously). Engng-Oct. 4. 1500 w.

2131. Training the Untrained Horseless Carriage. Payson Burleigh (Points out that the feature of automotors that will require most attention is the Steering gear. Next in importance will be the brake). Age of St-Oct. 12. 1500 w.

*2141. The March of Invention. N. S. Shaler (Concerning the channels in which invention has run, showing how science and mechanical skill have improved the condition of civilized man). Chau-Nov. 3200 w.

2143. Units of Force and of Mass. G. A. Goodenough (A criticism upon a previous article in *American Machinist* on this subject, and an explanation of the proper meaning and use of these units in mechanics). Am Mach-Oct. 24. 2000 w.

2144. Unmechanical Devices. Frank Richards (What is meant by mechanical and unmechanical devices. A criticism upon some devices in common use in shops). Am Mach-Oct. 24. 1400 w.

*2164. Self-Propelled Road Carriages at Tunbridge Wells (An account of self-propelling vehicles exhibited at an agricultural show in which the types are pronounced good, but the opinion is expressed that much better ones are possible). Eng, Lond-Oct. 18. 1100 w.

*2167. The Serpollet Steam Road Carriage-Ill. (Detailed description. First number discusses difficulties of the problem, fuels for self. propelled carriages and the steam generator used by M. Serpollet). Engng-Oct. 18. Serial. 1st part. 2800 w.

*2169. New Saw-mill at Gloucester (Illustrated detailed description. Three full page sheets of drawings of details). Engng-Oct. 18. 1500 w.

*2173. Horseless Carriages at Tunbridge Wells (Illustrated description of the vehicles exhibited and of their performance). Irm-Oct. 19. 1200 w.

2180. Producer Gas in the Production of Power. W. J. Taylor (A letter giving some interesting views and notes on the advantages of gas engines, stating that they consume but half the quantity of coal required by a steam engine). Ir Age-Oct. 24. 600 w.

†2185. Aerial Mechanical Flight. C. H. Mitchell (This paper deals exclusively with the latest branch of aeronautics, aviation or mechanical flight, its history, aims, designs, and possibilities, taking the ground that engineers should at once make themselves sufficiently familiar with it to be prepared for its actual development considered to be assuredly not far distant. Discussion. Numerous cuts and diagrams illustrate the text. A very interesting and instructive paper). Eng Soc of School of Prac Sci-No. 8. 19000 w.

*2219. Horseless Carriages. David Salomons (Their early history, the relation to laws of the road, modern developments and probable results are dealt with in the first number). Prac Eng-Oct. 18. Serial. 1st part. 3200 w.

*2252. Stone Sawed Like Wood (A description of the work done by the Peckover improved stone saw). So Arch-Oct. 600 w.

2254. Local Annealing of Hard Faced Armor Plates. Ill. Hermann Lemp, Jr. (Abstract of paper read before the Amer. Inst. of Elec. Eng. A description of the process and apparatus necessary. Experiments described, and methods formerly used explained). Elec Eng-Oct. 30. 2800 w.

2282. Some Speculations Regarding Rapid Transit. Ill. John Brisben Walker (A consideration of the interesting problem of rapid transit, with the effect it will have on nearly every relation in life. Predicting that it will revolutionize our methods of living, and have an important bearing upon questions political and governmental). Cos-Nov. 2000 w.

2350. Indicator Rigging for Locomotives. Ill. (Description with diagram giving the dimensions of the indicator rigging employed on the Flint and Père Marquette locomotives). Eng & R R Jour-Nov. 1. 500 w.

2351. Rope and Belt Transmission. V. Dubreuil (Abstract of paper read before the Society of Civil Engineers of France, covering in a comprehensive manner the conditions most favorable for rope transmission). Eng & R R Jour-Nov. 1. 900 w.

*2356. Observations on the Lille Experiments on the Comparative Efficiency of Ropes and Belts for the Transmission of Power. David S. Copper (Abstract of important paper read before the Inst. of Mech. Eng., London. Gives tabulated results of experiments named in title, with general description of the arrangement of the machinery, a résumé of previous experiments and general remarks). Ind & Ir-Oct. 25. 3000 w.

*2413. Rotary Flour Bolts (Describes and illustrates the McAnulty Rotary Sieve Bolt and discusses its operation at length). Am Miller-Nov 1. 2000 w.

*2414. Bolts and Bolting. Alex. Dobson (Describes a very interesting series of finally successful experiments designed to improve the effectiveness of bolting reels). Am Miller-Nov. 1. 1800 w.

2426. The Kane-Pennington Motor. John Randol (An illustrated description of one of the most remarkable oil motors yet produced. The statement is made that 4¼ h. p. are obtained from an engine weighing only 17½ lbs., running at a regular speed of 700 turns per minute). Am Mach-Nov. 7. 3300 w.

2430. The World's Injustice to the Technical Man (Address of Mr. George W. Dickie before the Technical Society of the Pacific Coast, at an informal meeting held at San Francisco, Oct. 5). Am Mach-Nov. 7. 2000 w.

†2449. Our Unsatisfactory Patent System (Editorial criticism). Ind Rub Wld-Nov. 10. 900 w.

MINING & METALLURGY

Is an American Mining Boom in Sight?

THE question seems settled as to the growing interest in American gold mines. There has even been a mild effort to "boom" mining shares in the smaller cities, but all eyes are turned expectantly to South Africa, waiting to see what will happen. In order to show the comparison between some of our mines and the subject of the "Kaffir" speculation, *Bradstreets* (Oct. 26) quotes from the Denver *Republican:* Johannesburg (S. A.) "is producing about 260,000 tons of ore monthly, representing a gold output of about $3,000,000. The average value of the ore rarely exceeds $12 per ton, and the richest ore is about $25 per ton. The Cripple Creek district is producing about 15,000 tons of ore monthly, with a gold output of about $900,000 a month, the ore averaging $65 per ton. The Johannesburg ores are treated by stamp mills, and the tailings are then subjected to the cyanid process. The district has reached its development after enormous expenditure of capital and nearly 10 years of development. Without the aid of any outside capital, Cripple Creek has within three years reached a production one-third of that of South Africa. When the time comes for the enormous deposit of low grade ore at Cripple Creek to be treated any way near as cheaply as the cost at Johannesburg, Cripple Creek, the *Republican* claims, will produce more gold than Johannesburg. . . . . For several years past the efforts of prospectors have been directed to making discoveries of gold. The results of this activity are seen in the increase of the country's gold production, which for 1894 is estimated by the director of the mint at $39.500,000, as against $33.000,000 in 1892. The basis is certainly here for a development of the gold-mining industry of the United States with the aid of capital drawn from the public." A "crash in Kaffirs" does not seem imminent, though they will find their level in the near future, and, public confidence being reassured, capital will undoubtedly flow to enterprises as profitable as legitimate gold mining has become.

The Kaffir Craze.

SPECULATION in South African mining stocks is at its ebb. Not only has British capital poured its millions into these ventures, but French and German capital, followed by the Swiss and the Austrian, has gradually caught the fever, so that many of the most popular shares are sold ridiculously far above their possible value. Notwithstanding the enormous interests involved, says *Bradstreets* (Oct. 19), "accurate information relating to the ore deposits and the methods of working have remained very inadequate." The early mining, beginning about 1869, was confined to rich pockets in the outcrop, and it was some time before it was discovered that the conglomerate was the ore-bearing rock and the real ore.

"The Witwatersrand gold-bearing rock is remarkable for its enormous extent and wide distribution. The geological formation is made up of sandstone, quartzites, shales, schists, etc., among which occur a number of beds of the conglomerate in which the gold is found. These reefs are, in some cases, found only a few hundred feet apart, and vary very much in thickness. Six of them are clearly defined, and have been located for miles. They consist of masses of water-worn pebbles fused, and have apparently been tilted up through the upheaval of intrusive masses of diorite formation, dykes of which penetrate the country, intersecting the gold rock and producing in the latter a large number of faults and breaks. The strata in which the gold is embodied tilt up from the north and dip toward the centre of the basin, flattening at angles from 80° to 10°. The basin is, so far as traced, some 130 miles long by about 30 miles wide, the irregularities already referred to not being sufficient to prevent its extent being delineated with considerable accuracy. The various beds of conglomerate are parallel to each other, and, while the seat of the principal mining is along a line 36 miles in extent close to Johannesburg, the line of six separate parallel reefs has been traced for 135 miles between Klerksdorp and Heidelberg, and is being worked in parts. The ore is what is described as 'free milling' down to the water line, or about 150 ft. deep, and amalgamates with ease on battery plates. At that depth it changes to pyrites and sulphurets, and can only be treated by the chlorination process. . . . The district, it must be admitted, is the greatest gold-producing region yet discovered. The total output of gold has been 6,538,393 ounces, which is about equal to $110,000,000 in value." The production of gold in 1895 will probably be $41,000,000.

"It will thus be seen that there is a basis for the exploitation of the district. It is the unjustifiable lengths to which the speculation has run that creates a dangerous situation. . . . According to a table in the London *Economist*, out of 131 mining companies operating in South Africa, most of them in the Witwatersrand, only 25 are dividend payers." The table is here given:

The following facts are quoted from an exchange showing the amount of inflation "in the 'Kaffir' market. The £1 shares of the City and Suburban Mine sold in September for £27, or 2700 per cent., while Simmer and Jack sold at 2175 per cent., Fereira at 2050, Crown Reef at 1200, and so on. Even more dangerous is the inflation in the unproductive companies. Most of these are 'deep-level' mines, which have before them an enormous expenditure ere they can become productive. An instance is given of the Rand Mines, the £1 shares of which sold at £38¼ or 3825 per cent. Altogether, the nominal capital of these concerns, reduced to our money, is $138,000,000, which at the market price had a speculative value of $566,000,000, or over 400 per cent. of their par." At least twenty-six trusts intended to hold stocks or to finance mines have been formed in addition, and we have the following remarkable summary.

	Capital.	Market price.	Market price. Av. p. ct.
Dividend mines......	$32,773,635	$192,822,000	588
Non-dividend mines.	138,649,770	569,145.230	408
Total mines	$171,423,405	$758,967,230	443
Trust, etc., Co.'s.....	79,363,395	317,895,890	401
Totals............	$250,786,800	$1,076,863,120	429

	Capital stock		Dividend %		Return on selling price.
Companies.	Par value.	Selling price.	Year 1894.	Half year 1895.	
City & Suburban	$ 425,000	$11,475,000	50	75	5.5
Crown Reef.......	600,000	7,200,000	50	25	4.1
Durban-Roodepoort	625,000	5,468,750	60	30	6.9
Ferreira......	450,000	9,225,000	150	65	6.3
Geldenhui's Estate.......	1,000,000	6,937,500	30	30	8.8
Geldenhui's Main Reef	750,000	1,230,000	..	10	12.3
Glencairn	1,125,000	4 992,000	12½	15	6.8
Jubilee................	250,000	2,687,500	120	60	11.5
Jumpers............................	500,000	4,375,000	55	25	6.0
Kleinfontein.....	925,000	5,435,000	12½	12½	4 3
Langlaagte Estate....................	2,350,000	15,860,000	45	25	7.5
May Consolidated......	1,262,500	4,853,000	..	10	5.1
Meyer & Charlton...	425,000	3,135,000	55	25	6.0
New Chimes	500,000	1,625,000	25	45	27.8
New Heriot....	443,750	4,881,250	40	90	16.3
New Primrose........................	1,393,750	10,800,000	40	25	6.5
Nigel................................	1,000,000	7,625,000	50	20	5.3
Orion	800,000	3,250,000	105	20	8.8
Robinson...........................	13,750,000	30,593.750	10	6	5.5
Roodepoort United.	750,000	5,906,250	20	25	6.3
Simmer & Jack.......	1,250,000	27,187,500	30	20	2.0
Stanhope	170,000	262,500	100	30	40.0
Transvaal Gold	1,300,000	12,510,000	10	10	2.1
Wemmer............................	275,000	3,095,000	..	100	17 5
Worcester....	453.635	2,211.500	70	30	6.3
Totals....	32.773,635	192,822,000	..	35.9	61.

"As the average expense of working the largest and best conducted mine is 70 per cent. of the output, it can be seen that the capitalization is in excess of the results, and that the speculative value outruns all reason."

Aluminum Solders.

OWING to the difficulty of soldering aluminum satisfactorily, its application to the more finished work in the arts has been retarded. The difficulty arose in securing a solder that would attach itself to the metal, and this difficulty formed the basis of remarks made by Mr. Joseph Richards before the Franklin Institute, an abstract of which appears in their *Proceedings* (Nov.). In describing his own experiments, he "proceeded with the object of finding, if possible, a solder which should have the following qualifications: (1) it must wet the aluminum and adhere firmly; (2) it must not disintegrate after exposure to the air; (3) it must be as malleable and strong as aluminum; (4) it must have a low melting-point, so as to be easily worked with a soldering-iron; (5) it must have the same color as aluminum and not change color; and (6) it must be cheap enough for general use. After experimenting for about 2 years, it was finally found that an alloy of zinc and tin in certain proportions, containing a little aluminum and some *phosphorus*, realized almost every qualification." On fusing this first solder, it was found that a less fusible alloy liquated off. Supposing this to be the more stable alloy, having a formula expressed very closely by $Sn_4 Zn_3$, the solder now used was made accordingly, and is given below:

	Original Solder	Found in the liquated alloy	The formula $Sn_4 Zn_3$ calls for	Solder, as now made, contains	
Aluminum.......	2 38	.....	...	2.38	Zinc + aluminum, 28.57 p. c.
Zinc...	19.04	.....	29.3	26.19	
Tin....	78.34	71.65	70.7	71·19	
Phosphorus ..	0.24	....	... ...	0.24	

"Though this solder is in use in both Europe and America, it must be remembered that at present the demand for an aluminum solder is limited. About 4 tons of aluminum are now produced daily in the world, but fully 75 per cent. of this is used up in the steel industry and in making alloys; while, of the remaining 25 per cent., which is rolled, spun, cast, or stamped into pure aluminum articles, probably not 10 per cent. is in such shape as to require soldering. Assuming then an average of 200 lbs. a day of aluminum articles to be soldered, a daily supply of a very few pounds of solder would meet the entire demand."

A Flume Coal Conveyor.

THIS novel form of coal conveyor, which transports small coal 8400 ft. from the washer to the coke ovens 1000 ft. lower in elevation, is now in operation at Horr, Montana. The Montana Coal and Coke Co., which operates the mines, found tramways and inclines too expensive when of sufficient capacity, and hope to save in a few months, by this new method, the entire cost of construction of the flume. Mr. B. L. Lloyd very entertainingly describes the conveyor in *The Colliery Engineer and Metal Miner* (Oct.), explaining the difficulties in location and construction. "When the writer ran the levels, he found that there was 128 ft. fall from the coal washer to the track at the first 'divide,' which is at the end of the first tramroad and the head of the first incline. This gave him a minimum gradient of 2.8 per cent.," which was consequently the minimum on the whole course. "Of course, when following the minimum grade, we took the best alignment we could get without too much grade work. It was side-hill work. We excavated, on an average, enough room for the boxes to rest on solid ground, making about half a dozen through cuts and putting in about a dozen small trestles. . . . . The boxes were made of undressed 2-in. fir plank, having 8-in. bottoms and 10-in. sides, thus giving an 8 × 8 in. opening. The sides were spiked to the bottoms with 30-penny wire nails, which were put at intervals of about 6 in.; collars of 2 × 6 in. plank were fitted with some care at each joint, and were put around the boxes at the centre to keep them from warping or twisting. The planks were in lengths of 12, 14, and 16 ft., —mostly 14 ft.,—and were usually cut in two, making short lengths to go around curves. The joints could not be better. It was calculated that, while at first a very little water might leak at the joints, they would soon fill up with fine coal, which was found to be the case, the flume not leaking at all now. The trestles, not being in any place very high, were built of 4 × 4 in. lumber, with simply a cap piece 4 ft. long and two batter posts, which were clapped into and 'toe nailed' to the cap piece. Where trestles occur, it is intended to box in the flume with boards and fill in with saw-dust. The other portions will be filled around with earth and covered with boards.

"The flume has almost exceeded our expectations. It is working beautifully. It carries over all the coal that is put into it without cost, except interest on its construction." The coal is freed from water at the terminus by running the flume into settling tanks arranged in pairs, as then one can thus be emptied while the other is filling. These four tanks are built in pairs over the drying bins, 6 ft. wide and 6 ft. deep, and the same length as the bins. "When the first tank fills and the water first overflows, it is perhaps one-third full of coal, the water there overflowing carrying with it, in suspension, very fine particles of coal, almost as fine as flour, settling in the second tank." This fine coal makes good coke. The coal, after draining and drying, is converted into coke by the company's ovens, and used by Montana and Idaho smelters. The author concludes by explaining that "the flume, on all except the minimum grade, was lined with sheet iron to prevent wear. It seems to be something like the 'Kodak'; you put in the coal, and the water and the flume do the rest." They also contemplate the erection of a larger flume to convey the lump coal.

Electrical Mine Haulage.

Ernock Colliery has been in operation for 15 years in the coalfields of Lanarkshire, Scotland. The deposit worked includes five seams, and all haulage was done formerly by means of steam engines, horses, and self-acting inclines. The *Canadian Mining Review* (Oct.) abstracts the following in relation to it from the *Proceedings, Institute of Civil Engineeers.* "Taking the present output by the two electrical hauling engines at 600 tons in 10 hours, it is estimated that, even if the same work could have been done by horses, it would have required forty horses and forty men, in addition to those now employed at the working face, to do the same amount of work. The annual cost of working with forty horses is therefore:

Depreciation and renewal of 40 horses 15 per cent. of £1200	£ 180
Keep of 40 horses, £30 per annum...	1200
Wages of 40 men, 5s. 6d. per day for say 250 days.......	2750
Total...........................	£4130

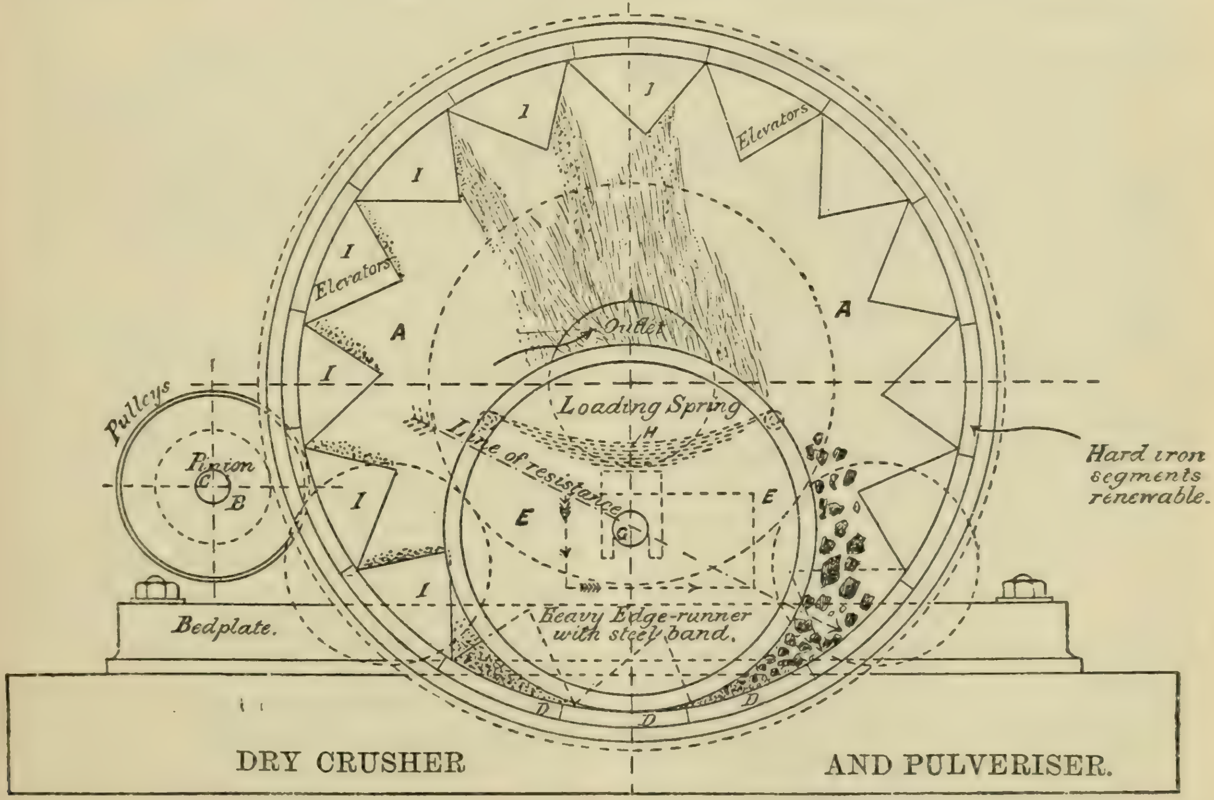
"The annual cost of working and maintaining the electric installation replacing horses is:

One electrical engineer 10s. per day for 250 days...........	£125
Twelve men at 6s. per day for 250 days	900
Coals, oil, stoves, etc...............	500
Upkeep and depreciation :—	
Building, say 5 per cent.........	30
Machinery, pulleys, ropes, etc., 15 per cent. on £2900..............	435
Total................................	£1990

"Deducting the cost of working and upkeep of the electric-haulage plant from the estimated cost of doing similar work by horses shows the substantial saving of £2140 per annum to be effected by the electrical installation . . . . From experiments to test the efficiency of the plant, the following information was obtained: the loss in the engines is about 16 h. p.; in the shafting, about 0.45 h. p.; in belt and dynamo-friction, 3.4 h. p.; and in exciting the dynamo, 2.2 h. p. These losses, approximately constant for all loads, amount to about 22 h. p., and constitute the engine-room losses. The loss in the engine is large, on account of the available steam pressure being low,—only 50 lbs. per sq. in."

A Dry Crusher and Pulverizer.

NOTWITHSTANDING the large number of good pulverizers and disintegrators on the market, a new candidate for favor appears under the name of The Niagara Dry Crusher and Pulverizer. It possesses many valuable features, such as readily accessible bearings, easily-regulated fineness of product, and compactness. It has proved a success in English cement manufacture, owing to the remarkable fineness of the product and comparative great capacity. Though better adapted to the less hard materials, it has been used on gold quartz. According to *The Colliery Guardian* (Oct. 4), "the largest size made at present is the 6-ft. machine, which will grind 20 cwt. of hard quartz per hour to pass a sieve forty meshes per linear inch with an expenditure of 11 h. p. The machine is run at a comparatively slow speed, not exceeding forty revolutions per minute, and the crushing surfaces do not come into immediate contact as they revolve. Both the grinding path in the drum and the ring of the roller are made of chilled iron, and can readily be replaced when worn. The drum, A, shown in diagram, is toothed externally and driven by a pinion, B, on a lay shaft, C. The crushing roller, E, which runs inside the drum on the path, D, is keyed on one end of a shaft, G, mounted on a swivel bearing at its outer end and running in a long intermediate bearing, which is pressed downwards by a powerful leaf spring, H. The drum itself is carried by four anti-friction rollers. Material is fed under the leading side of the roll, and, after crushing, is lifted by a number of scoops, I, fixed inside the drum on each side of the grinding path. These lift it and discharge it over the roller, which leads back any uncrushed material to be re-treated, whilst the fine material, as it falls, is at once removed by a blast of air produced by a suction fan. The air used circulates through the machine and pan over and over again, and, if necessary, it can be passed through settling chambers, where the finest dust can be deposited. By properly regulating the speed of the fan and the draught produced by it, crushed material of any desired size may at once be removed. When granulated or coarse products are desired, the roller is set up slightly. All the journals and bearings are placed externally to



DRY CRUSHER AND PULVERISER.

the machines, so that they are readily accessible and can be protected from dust; but, as the air circulates continuously without any escape, there is but little dust to be seen about the machines, except that made by feeding at the hopper. The machine is self-contained and requires comparatively small foundations, running without much noise or vibration. When treating gold quartz, it is found that, by adjusting the speed of the air-current, a very good dry separation is produced, rich sand falling separately from the poor tailings. For tough substances the grinding surfaces are corrugated. The crushing in this machine, as is seen from the use of a fan, is done in the dry state, so that clay or wet material cannot readily be treated in it; but for thoroughly dry material the size of the product is remarkably uniform."

The Development of Iron and Steel Manufacture.

ADVANTAGE has been taken of the opportunity afforded by various international exhibitions in France to collect data relating to the condition of the iron and steel industry of the world. Mr. Shroedter, in a paper before the German Iron-masters' Association on "Iron and Steel Statistics," gives the following table of production in the exhibition years specified:

WORLD'S PRODUCTION OF PIG IRON.

(IN THOUSANDS OF TONS).

Country.	1867.	1878.	1889.	1893.
France.	1,239	1,508	1,734	2,032
Belgium..........	423	519	832	760
England..........	4.839	6,366	8,458	6,930
Germany........ ...	1,264	2,148	4.524	4,953
America	1,326	2,338	7.872	7,239
Other countries ..	934	1,419	2,609	4.875
Totals	10,013	14,298	26,027	26,989

In abstracting from the *Memoirs de la Société des Ingenieurs-Civils* (June), the *Iron and Steel Trades Journal* (Oct. 19) says that the improvements in steel manufacture are due to the "method of scientific and experimental research applied to the manufactures in France, where, he maintains, the progress made has been unquestionably greater than elsewhere, and where processes invented by foreigners have met with greater success. . . . During the first months of 1895 several manufacturers attempted the production of a steel possessing the following qualities:

Elastic limit... 56,893 to 64,004 lbs. pr. sq. in.
Ultimate tensile strength. ...113,786 " 184,902 " " " "
Elongation.......................30 per cent.

"Although entire success has not been met with, some remarkable results were obtained as here shown:

	No 1. lbs. per sq. in.	No. 2. lbs. per sq. in.	No. 3. lbs. per sq. in.	No. 4. lbs. per sq. in.
Limit of elasticity.	47,505	47,505	56,181	61,871
Resistance..........	95,011	98,709	107.811	126,586
	Per ct.	Per ct.	Per ct.	Per ct.
Elongation......... .	46.0	47.5	49.8	35.6
Contraction	66.6	71.2	61.6	57.0

"The author thinks that chemical combinations exist which have not yet been revealed. Up to the present the attention of manufacturers has been confined to the mechanical properties and chemical composition of the metal; when it shall have been turned to the study of the molecular state, the author considers a great improvement in quality may be looked for, and maintains that this desideratum will undoubtedly be accelerated by the publication of the results of the experiments undertaken by the commission appointed in 1891 by the minister of works for France to experiment on materials of construction."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Technical Journals—See Introductory.

Metallurgy.

*1907. Determination of Chrome and Manganese in Steel. L. Schneider (A new method described in detail). Ir & St Tr. Jour-Sept. 28. 400 w.

1925. Pittsburg's Iron and Steel Industry as Seen by an Engineer (Present development at Pittsburg, especially of the Edgar Thomson Steel Works, and the Homestead Steel Works; also the situation at the National Tube Works, Duquesne Steel Works, the Westinghouse and other works of that region). Eng News-Oct. 10. 6700 w.

1931. The Ackerman method of Face-Hardening Armor (A method for increasing the thickness of the carbonized surface of a steel plate by producing folds or ridges on the surface before cementation, and then forging as usual). R R Gaz-Oct. 11. 1900 w.

†1939. The Estimation of Sulphur in Refined Copper. G. L. Heath (Read at the Springfield meeting. Calling attention to defects in methods already published, and presenting results of some experiments and an improved method, devised especially for the determination of traces of sulphur). Jour Am Chem Soc-Oct. 2300 w.

*1972. The Alleged Treacherousness of Ingot Iron (The report of the Committee of the International Conference on methods of testing structural materials, giving results of investigations at Zurich, and conclusions). Eng, Lond-Oct 4. 2000 w.

*1977. The Manufacture of Tool Steel in Styria and Lower Austria. From *Stahl und Eisen* (Description of the present practice at that locality in the crucible steel works). Ind & Ir-Oct. 4. 1200 w.

*1985. The Cost of Producing Iron and Steel in Belgium (Abstract from *The Revue Universelle* of calculations by M. J. Wolters, on Belgian girder manufacture). Ir & Coal Tr Rev-Oct. 4. 700 w.

2111. An Improved Ten-Ton Chlorination Barrel. John E. Rothwell (Description with detail drawings. A statement of its advantages over two five-ton barrels). Eng & Min Jour-Oct. 19. 600 w.

2122. Iron Manufacturing on the Congo (An interesting sketch of the progress of the industry among the natives). Am Mfr & Ir Wld-Oct. 18. 450 w.

*2138. The "Ropp" Straight Line Furnace. Ill. (Somewhat similar to the O'Hara type, or the Brown Horseshoe furnace straightened out; the stirrers return along the side of the furnace. It is said to have given very satisfactory results). Aust Min Stand-Sept. 7. 1800 w.

2160. Pittsburg's Lost Supremacy (An opinion of Mr. Andrew Carnegie respecting the effect of a Pittsburg Lake Erie canal, estimating a saving of $1.40 for each ton of steel manufactured, by help of such cheap canal transportation). Ir Tr Rev-Oct. 24. 800 w.

2174. Some Fuel Problems. Joseph D. Weeks (Address delivered at Atlanta before the A. I. M. E. A general view of fuels followed by remarks upon the mining use, and handling of coal waste, and upon coke manufacture). Am Mfr & Ir Wld-Oct. 25. 4000 w.

2181. Tin Plate Production (A report to the U. S. Treasury Department by Col. Alger giving interesting statistics. There are 48 firms in the United States manufacturing tin plates, giving an increased production during the past fiscal year of 87½%). Ir Age-Oct. 24. 1000 w.

*2236. Recarburation of Steel in the Basic Converter by Means of Calcium Carbide (Quoting from an article in *The Iron Age* and giving some results communicated by a German Commission indicating that the process is impracticable). Ir & Coal Tr Rev-Oct. 18. 900 w.

2239. Tests of Tough Steel Castings. Ill. Gus C. Henning (Tests of coupons cast on a spider anchor plate for a suspension bridge, showing some excellent results. The castings are not allowed to cool in the sand but are transferred, while still red hot, to the annealing oven). Eng News-Oct. 24. 700 w.

2245. Recent Progress in Iron and Steel Manufacture (An interesting editorial pointing out the later improvements and showing the tendency to be toward "aggregations of capital in the shape of massive automatic machinery, and in the consolidation of all branches of the industry"). Eng News-Oct. 24. 1000 w.

2263. Occurrence of Tellurium in Oxidized Form Associated with Gold. Richard Pearce (A paper read before the Colorado Scientific Society, showing that with the South Dakota ore containing tellurium, the presence of pyrite affected the quantity of tellurium oxide upon roasting). Min Ind & Rev-Oct. 29. 1200 w.

2565. Metallurgical Works in New South Wales (Editorial. A new enterprise with £500,000 capital, proposing to treat the refractory Broken Hill ores by chemical means, employing the Storer-Marsh and Siemens-Halske processes). Aust Min Stand-Sept. 21. 1500 w.

2276. The Value of Practical Tests of Refractories. Charles Terry (An interesting series of observations to the effect that the qualities of fire brick can be known only by practical tests under working conditions). Ir Age-Oct. 31. 2200 w.

2277. The Slavianoff Electric Metal Casting System (The metal in the shape of a rod conducts a current direct from the dynamo, which is sufficient to melt the rod at the point of contact enabling one to cast one metal on another, mend castings or make new castings. Used by Julius Pintsch, Berlin). Ir Age-Oct. 31. 1500 w.

2298. The Iron and Steel Industries of the United States in the Census year 1890 (Abstracts from a report of the U. S. Commissioner of Labor, being Part III. of the final reports of the census of 1890, giving the number of iron and steel works at 719; the invested capital $414,044, 844; net tons product 18, 216, 215). Bul Ir & St Inst-Nov. 1. 800 w.

2299. The First Iron Enterprises at Pittsburg and in Allegheny County (An account of the early years of the Pittsburg iron industry. The first furnace was completed in 1792; the first foundry in 1803; the first steel furnace, 1810: the first rolling-mill in 1811 and 1812; the Clinton Furnace first used coke in 1859. The last furnaces put up are 100-ft. high and 22-ft. diameter at bosh). Bul Ir & St Inst-Nov. 1. 2000 w.

*2322. The Development of the Iron and Steel Manufacture as Shown by Recent Exhibitions in France (Read before the French Society of Civil Engineers, comparing the production of various countries and the improvements in the quality of steel). Ir & St Tr Jour Oct. 19. 700 w.

2338. Russia's Iron and Steel Industry. Charles Hyde (Paper read before the Eng. Soc. of W. Penna. giving interesting notes of a trip through the Russian iron works, showing the industry more advanced than is generally supposed). Ir Tr Rev–Oct. 31. 3000 w.

2342. Plant for the Extraction of Gold by the Cyanide Process. Charles Butters and Edgar Smart (Abstract of paper in "Pro. of the British Inst. of Civ. Eng. Deals with the mechanical treatment principally and is well illustrated with drawing of South African plants). Eng & Min Jour–Nov. 2. 3500 w.

*2358. Nickel Steel and Armor Plates (A communication giving some of the most valuable properties of nickel steel, recommencing it for boiler plates, and stating that it can be welded and will not readily corrode). Ind & Ir–Oct. 25. 1600 w.

Mining.

*1896. Side Lights on the South African Gold Boom. Albert Williams, Jr. (Comparing the "Kaffir" craze with the speculative fevers of the past, and outlining in a general way the ultimate results). Eng Mag–Dec. 3500 w.

1940. The Gold-Silver Veins of Ophir (Extract from a monograph by Waldemar Lindgren, published in the 14th Annual Report of the U. S. Geological Survey. The portion of the article relative to the gangue, and the altered wall rock). Min & Sci Pr–Oct. 5. 2400 w.

1949. The Lignite Industry of North Dakota (Brief description of these extensive deposits with methods of operating the mines). Am Mfr & Ir Wld–Oct. 11. 800 w.

*1950. The Persistence of Mines in Depth. (Editorial. Concluding that indications are usually so unreliable that no opinion but that of a scientific geologist should be relied upon). Min Jour–Oct. 5. 1800 w.

2022. The Effect of Washing With Water Upon the Silver Chloride in Roasted Ore. Willard S. Morse (Read at the Atlanta meeting of the Am. Inst. of Min. Eng. The results of experiments showing the action of zinc blende and other sulphides in affecting the quantity of chloride of silver in the roasted ore after washing, and the losses occasioned thereby in lixiviation). Min & Sci Pr–Oct. 12. 2000 w.

2034. Comparative Methods of Gold Mining and Metallurgy. W. M. Brewer (Methods of mining, ore treatment and barrel chlorination in the South, compared with other localities and criticised as being behind the times). Tradesman–Oct. 15. 1800 w.

2037. The Magnetization and Concentration of Iron Ore. William B. Phillips (Read at the meeting of the Am. Inst. of Min. Eng. at Atlanta. The results of experiments at Bessemer, Ala., in concentrating a low grade hematite, rendering it magnetic by heating in a Davis-Colby kiln, and treating in a Hoffman separator. One ton of 55 per cent. ore was produced for $1.15). Ir Age–Oct. 17. 4500 w.

*2058. Coal Mining in the Province of Hanover (A review of the condition of the industry as brought out by the Mining Congress held at Hanover in September. The large quantity of coal converted into briquettes is a notable feature). Col Guard–Oct. 4. 1600 w.

*2060. The Niagara Dry Crusher and Pulverizer. Ill. (Description, with sectional illustration of one of the most successful fine crushers in use). Col Guard–Oct. 4. 600 w.

*2079 Hydraulic Pumping Plant at the Cefu Colliery Near Bridgend James Barrow (A paper read before the South Wales Inst. of Eng., describing with sketches nine pumps consisting of an ordinary pump at the surface which transmits its water under pressure, to the mine pump 820 yards below where it acts as the moving power). Col Guard–Oct. 11. 1500 w.

2120. Mining in Siam (A report made by the Siamese Consul General on the occurrence of various minerals, and the tin exported in 1893–94 with an outline of the conditions under which licenses and mining leases are granted). Min Ind & Rev–Oct. 17. 1700 w.

2123. The German Brown Coal Industry. Dr. Max Fiebelkorn (Translated from *Chemische Industrie.* A description of the Rolle Coking system and the utilization of by-products in coking of lignite). Am Mfr & Ir Wld–Oct. 18. 1300 w.

2125. No More Oil Well Shooting (Method consists of pumping water and acid to the bottom of the oil well where it dissolves the cementing medium of the rock, making it more open and thus letting the oil flow more freely). Am Mfr & Ir Wld–Oct. 18. 900 w.

*2126. The Amalgamation of Free Milling Gold Ores (Editorial criticism of an article, "The Mining Industry," which makes "mechanics subordinate to metallurgy." The editor argues that we must look to mechanical appliances for further development in amalgamation). Min Jour–Oct. 12. 1100 w.

2132. The Kaffir Craze (A very interesting account of the South African mines speculation, including a description of the deposits of gold ore and the extent to which inflation and speculation has gone). Bradstreet's–Oct. 19. 2300 w.

*2140. The Niagara Crusher and Pulverizer. Ill. (Consists of a heavy fixed edegrunner inside a revolving cylinder, crushing the material between them. Pockets at the sides of the roller and inside the barrel, drop the crushed material, which is sucked out by a fan while falling. It has done good work and is readily adjusted and repaired). Ir & Steel Tr Jour–Oct. 12. 1500 w.

2146. "The Coming Crash." Almarin B. Paul (Discussion of the South African gold mines speculations, holding that there is considerable backing in the natural resources of Africa to warrant the enormous amount of money sunk in these properties). Min & Sci Pr–Oct. 19. 1600 w.

*2210. Firedamp Imprisoned in the Coal of the Saint Etienne Mine, With the Means Taken for Ascertaining its Pressure. M. P. Petit (A communicatión to the Sociétè de l'Industrie Minèrale concluding that outbursts of gas are more liable to take place when the coal is compact, and that the distribution of regions of high gas tension is so variable that bore holes give no efficient relief. A good article giving results of experience in French collieries). Col Guard–Oct. 18. 5000 w.

*2211. Electric Light and Power in Mines. Sydney F. Walker (Description of different apparatus used for the generation and transmission of power in mines, the principles involved, and causes of failure). Col Guard-Oct. 18. Serial. 1st part. 2000 w.

*2213. The Kootenay Mines, British Columbia (A sketch of the geography of the locality, history, and descriptions of some of the principal mines). Min Jour-Oct. 19. Serial. 1st part. 4300 w.

2221. Is an American Mining Boom in Sight? (Giving examples of English capital coming to the United States and a comparison between Johannesburg production and profits and those of Cripple Creek as given by the *Denver Republican.* Concludes that prospects for future developments look bright). Bradstreet's-Oct. 26. 1500 w.

*2231. The Progress of the Cyanide Process (The use of the cyanide process on low grade gold ores, prospects of roll crushing in place of stamps, and description of some new plants and improvements). Mach-Oct. 15. 2500 w.

*2235. Welsh Anthracite Coal. Mr. Howard (Paper read before the Pacific Coal Gas Asso. Discussion of the bearing of Welsh coal on California industries, its competition wlth Vancouver bituminous coal and native petroleum, and the question of available fuels in general). Ir & Coal Tr Rev-Oct. 18. 2800 w.

2262. Placers and Gold Mines. A. L. (The condition of the gold placers in British Columbia). Min Ind & Rev-Oct. 24. 900 w.

*2264. Hydraulic Sluicing in New Zealand (An alluvial deposit comprising a mass of cemented breccia which was blasted in faces sometimes 100-ft. in height and sluiced, but now worked by improved methods which are described). Aust Min Stand-Sept. 14. Serial. 1st part. 1600 w.

2266. The Mechanical Separation of Lead. Zinc Sulphides. F. Hille (A comparison between American and German machines and methods with official figures from the Himmelfohrt mine, Saxony, on the results of concentration; also reference to the work of the British Columbia Mines). Can Min Rev-Oct. 1500 w.

2267. How Gold Occurs in Nature. W. Nichols (Digest of an elementary lecture delivered at Field's Columbian Museum, Chicago). Can Min Rev-Oct. 1800 w.

2268. Metal Mining. J. H. Collins (Extracts from a presidential address before the Institute of Mining and Metallurgy, London, on special features in mining, such as climate, scale of operations, pilfering, transit facilities, rates of interest, etc.). Can Min Rev-Oct. 1100 w.

2269. Electrical Haulage at Earnock Colliery. Robert Robertson (The saving effected by substituting electricity for horses). Can Min Rev-Oct. 300 w.

2279. The Anaconda Sale (Discussion of the reported sale of a ¼ interest in the Anaconda Mining Co.—whose property is valued at $30,000,oco,—to English capitalists. These mines hold the world's record of production, having made as high as 13,000,000 pounds of copper per month). Ir Age-Oct. 31. 500 w.

2286. Steel Frame Stamp Battery. Ill. (A type of double five stamp battery, built in England for South Africa. It is made almost entirely of iron and steel, with 850-lb. stamps and chrome steel shoes). Min & Sci Pr-Oct. 26. 600 w.

2287. The Sampling and Measurement of Ore Bodies in mine examinations. Edmund B. Kirby (A series of papers on the valuation of discovered ore, written in a comprehensive style). Min & Sci Pr-Oct. 26. Serial. 1st part. 900 w.

*2323. Humidity and Temperature Observations at the Maybach Colliery, near Saarbrucken. H. Fischer (Description of water spraying arrangement used in the hot, dry, deep workings to prevent the accumulation of coal-dust, which would produce serious disaster when ignited. Condensation in the upcast shaft amounts to as much as 8½ % of the total influx. The inside temperature was as high as 90° Fahr.). Col Guard-Oct. 25. 1500 w.

*2324. The Bernissart Collieries, Belgium (Description of a coal mine dating from 1830 and which possesses excellent communication facilities). Col Guard-Oct. 25. 1500 w.

*2359. Physiography and Geology of the Wadnaminga Gold Fields, South Australia. F. D. Johnson (A paper read before the Australian Inst. of Min. Eng. The ore bearing formations are described in detail). Min Jour-Oct. 26. Serial. 1st part. 3300 w.

†2373. What is Bitumen? S. F. Peckham (An investigation into the proper classification of bitumens, showing the distinction between terms commonly used). Jour Fr Inst-Nov. 4200 w.

2403. Big Mountains for Big Mines. Dan De Quille (A rule for prospectors indicating that the richest ores of the precious metals usually lie along the largest ranges, giving also some opinions as to conditions favorable for the presence of ore). Min Ind & Rev-Oct. 31. 2300 w.

*2447. The Swedish Iron Ore Industry (A description of the various deposits showing the surface magnitite to be higher in phosphorus, while the lower lying specular ores contain less. Most of the exported magnetites go to Germany). Ir & St Tr Jour-Oct. 26. 500 w.

*2460. Electricity in Bituminous Coal Mining. Ill. R. M. Haseltine (A rather long drawn out article describing the results of tests with electric mining machines in Ohio coal mines). Col Eng-Nov. 8400 w.

*2461. An Automatic Switch. Ill. (A switch designed for track running from a two compartment shaft, which is set by the cars running over it. It has been giving satisfaction in Pennsylvania coal collieries for a number of years). Col Eng-Nov. 600 w.

*2462. A Gravity Automatic Switch, Ill. J. J. Ormsbee (This device, which is in use at a Pennsylvania colliery in which a loaded car throws the switch rails down an incline laterally to its track, while the empty car has not sufficient weight to raise the counter weight and so goes straight ahead). Col Eng-Nov. 300 w.

*2463. The Capell Fan. Ill. (A cylinder fan having a vane device at entrance which acts like a screw-propeller, and short curved vanes along the periphery. The one described is 8 ft. diameter, 7 ft. long, with two inlets ; at 208 revolutions it delivered 108,000 cu. ft. of air per minute). Col Eng–Nov. 1000 w.

Miscellany.

1948. The Manufacture of Coal Briquettes. William Colquhoun (Abstract of a paper read before the Brit. Inst. of Civ. Eng. with illustrations of the various machines used and a description of the method of operating). Eng & Min Jour–Oct. 12. 3000 w.

*2078. The Geological Survey of Scotland and Ireland (From a report by Archibald Geikie, Director of the Survey, giving results of later investigations). Col Guard–Oct. 11. 4000 w.

*2080. Coal Mining in South Africa (Report on the coal deposits of Matabeleland and 140 miles northwest of Buluwayo. These coals contain 60 to 70% of carbon). Col Guard–Oct. 11. 700 w.

*2081. Report on the Quarter Colliery Explosion (Account of firedamp explosions in a Stirlingshire colliery with the evidence relating to the cause). Col Guard–Oct. 11. 2200 w.

*2121. The Mining Schools of Germany (A general review of advantages and course of study at Clausthol, abstracted from a U. S. Consular Report). Jour Soc of Arts–Oct. 11. 1100 w.

2124. Galvanic Zincing of Iron (Abstract from a work by Carl Richter, Leipzig, giving full details of the modus operandi, with necessary precautions). Am Mfr & Ir Wld–Oct. 18. 1600 w.

*2208. Output of British Minerals (Abstract from the official report on the mineral production of Great Britain with statements of imports and exports). Chem Tr Jour–Oct. 19. 1400 w.

*2209. Diving-Exercise Shaft of the Westphalian Miners' Association. H. W. Bracht (A shaft for the use of students when practicing the putting together of pipes, erecting pumps, etc., under water. Some students are unable to work at a depth greater than 11 fathoms, though the greatest practicable depth is 17½ fathoms). Col Guard-Oct. 18. 1100 w.

*2214. The Training of a Mining Engineer (An inaugural address by Henry Louis, Professor of Mining, before Durham College of Science). Min Jour-Oct. 19. Serial. 1st part. 2300 w.

*2215. The Gold Mines of the Rand (Editorial comment upon a new book published by Macmillan & Co., and reference to the opinions of Messrs. Smith and Hammond, experts, and to an article in the *Nineteenth Century*, treating principally of deep level mining, and showing that the deposits are immense). Min Jour–Oct. 19. 3200 w.

2278. The Mining Building at the Atlanta Fair (Description of the building and the principal mining exhibits at the Atlanta Exposition). Ir Age–Oct. 31. 1500 w.

2280. Analytical Methods at Duquesne. J. M. Camp (From a paper read before the Eng. Soc of W. Penna., on methods in use in the Pittsburg region in the chemical determination of iron, manganese, and phosphorus contained in iron and iron ores, and also nickel in steel). Ir Age–Oct. 31. 2400 w.

2302. An Ore Testing Plant. H. C. Cutler (Description of the Mining and Metallurgical Equipment of the University of Minnesota having a capacity for heating ore in lots from 500 lbs. to one car load. The equipment cost $6000 and is said to be full size). Sci Am Sup–Nov. 2. 800 w.

†2311. On the Analysis of Alloys of Lead, Tin, Antimony and Arsenic. Launcelot Andrews (Description of two quick methods giving close results). Jour Am Chem Soc–Nov. 900 w.

†2312. The Determination of Graphite in Pig-Iron. P. W. Shimer (The sources of error due to solution in H. Cl. an account of the presence of titanium and other carbides which would be dissolved in nitric acid solutions). Jour Am Chem Soc–Nov. 900 w.

†2313. On the Volumetric Determination of Titanic Acid and Iron in Ores. H. L. Wells and W. L. Mitchell (Describing the advantages of solution in sulphuric acid and the accuracy of the volumetric method). Jour Am Chem Soc–Nov. 1600 w.

†2314. The Evolution Method for the Determination of Sulphur in White Cast-Iron. Francis C. Phillips (Based on the assumption that the contained sulphur unites with the escaping hydrogen, forming hydrogen sulphide. Giving the results of various experiments). Jour Am Chem Soc–Nov. 3000 w.

†2315. On the Volumetric Determination of Lead. Allerton S. Cushman and J. Hayes Campbell (A description of the modified Schwartz method in which lead is precipitated as a chromate). Jour Am Chem Soc–Nov. 1000 w.

†2371. Aluminum Solders. Joseph Richards (Short history with analyses made in the development of a satisfactory solder. The solder as now made contains aluminum, zinc, tin, and phosphorus). Jour Fr Inst–Nov. 1000 w.

†2374. On the Technical Analysis of Asphalts. Samuel P. Sadtler (An improved method for the determination of "petrolene" and "asphaltene" in asphalts, using acetone to extract the former and chloroform to extract the latter). Jour Fr Inst–Nov. 900 w.

2404. Geology of Cripple Creek.—Report of the United States Geological Survey.—Mining Geology. R. A. F. Penrose, Jr. (The region is dictinctly gold bearing and the article describes the manner of occurrence of gold as being principally in dykes and fissures in granites and in eruptive rocks). Min Ind & Rev–Oct. 31. 2500 w.

2448. West of Scotland Iron and Steel Institute (Condensed address by the president on technical education, contrasting the excellent scientific schools of Germany and the United States, with the less efficient ones of England, and giving this as a cause for the superior development of practical metallurgy in the former countries). Ir & St Tr Jour–Oct. 26. 800 w.

MUNICIPAL ENGINEERING

Vitrified Paving Brick.

THE term "vitrify" is defined by Webster as meaning to "convert into glass by fusion, or the action of heat." "Vitrified," therefore, according to this definition, means converted into glass by fusion, or the action of heat. The "Standard Dictionary," recently issued, defines "vitrified" as "converted wholly or *externally* into glass or a glassy substance, . . . as vitrified brick, vitrified pottery, etc." The "Century Dictionary" says that *vitrified* means "converted into glass, hence, by extension, *partially converted* into glass," etc. The last two definitions are seen to include the technical meaning of the word as applied to incipient vitrification in many materials, as, notably, paving brick, which, if completely vitrified or wholly converted into glass, are, according to Professor H. A. Wheeler, in his new treatise,* inferior to those vitrified to a stage of incipient vitrification. But what he says upon this topic in his excellent little book is so interesting and instructive that we prefer to quote it *verbatim.*

"There is a misconception among some engineers and brick-makers as to the definition of vitrified brick, as, unless a brick shows a decidedly glass-like fracture, they refuse to call it vitrified, and even condemn brick, from the lack of such glassiness, that are not infrequently the toughest and most durable of pavers (brick with a stone-like fracture). They quote Webster to substantiate their claims, thereby failing to discriminate between a popular definition and a technical or special use of the term. The No. 1 pavers that are at present on the market, whether made from impure fire clay or shale, are nearly always vitrified, though much more thoroughly vitrified in the latter case.

"To properly appreciate the correct use of the technical term, vitrified brick, it is desirable to look at the change that occurs in paving clays in passing from the condition of a mud to a distinctly glassy mass. A plastic clay, when mixed with a proper amount of water, makes a mud or paste that can be readily molded, and yet is tenacious enough to retain the shape given to it in molding, if carefully handled. On drying off the mechanically-admixed water that rendered it plastic, it shrinks 2 to 11 per cent. to a firm earthy mass that bears handling, though it is so soft as to be easily scratched by the finger-nail, and the individual particles of clay are easily distinguished. On heating the dry clay to a red heat for about 1200 deg. (F.), the chemically-combined water is driven off, which renders the clay non-plastic, and it again begins to shrink and to grow harder and stronger as the heat is raised above redness; but the individual particles of clay are still easily recognized, and the clay is very porous. When the heat is further raised to about a bright cherry heat (or from 1500 to 1800 deg. F.), depending on the particular clay, it shrinks an additional 1 to 10 per cent.; it is very much stronger, much less porous, has acquired the hardness of tempered steel, and the individual particles are no longer recognizable. This point, which is quite well defined, I have called the point of incipient vitrification; from thence to the stage of a molten mass there is no longer any sharp line of demarcation, as it imperceptibly becomes more and more vitreous, and gradually begins to soften and change its shape, especially under pressure. It finally becomes a very viscous semi-liquid, and, when chilled and broken, presents a thoroughly glassy appearance.

"From the point at which the clay particles have sufficiently coalesced that they can be no longer recognized, or the point of incipient vitrification, to the point of viscous liquidity, requires an increase in temperature of 100 to 600 deg. F., depending on the kind of clay, and is usually 400 deg. in the clays suitable for paving brick. Midway between these two points the clay ceases to be porous and stops shrinking; it has attained its maximum hardness, or scratches quartz; it has a maximum toughness and cross-breaking strength, if slowly cooled, and the fracture shows complete coalescence of the particles, or it is completely vitrified, though the shape is retained if not subject to pressure. This stage, though not sharply defined, I have called the point of complete vitrification; though difficult to describe, it is quickly and easily recognized by the trained eye. It is the stage that clay should be brought to in order to make an ideal paving brick. If heated higher, there is a slight loss in hardness, a much greater risk of brittleness, and a marked tendency to be distorted from incipient flow, though the fracture is more decidedly glassy; yet this advanced stage is what some think a brick should be brought to in order to be called vitrified from Webster's point of view.

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* Vitrified Paving Brick. A Review of Present Practice in the Manufacture and Use of Vitrified Paving Brick. By H. A. Wheeler, E. M., clay specialist of the Missouri geological survey. Indianapolis, Ind.: T. A. Randall & Co., 1895.

" Salmon brick, having been exposed to only a red heat, are extremely porous, and they absorb from 15 to 30 per cent. of water; they are very soft, or from 2.5 to 3.0 in hardness, and are in the initial stage of shrinking, hardening, and strengthening.

" Hard building brick, having been raised to a cherry red heat, are less porous, and absorb from 6 to 15 per cent. of water; they are much harder, or from 4.5 to 5.5 hardness, are much stronger, and, while showing considerable shrinking, the distinct grains of the clay are still evident.

" Fire-clay paving brick usually exhibit a homogeneous, compact, dense body, in which the grains of clay can no longer be discerned, and have reached the stage of incipient vitrification; they are slightly porous, or absorb from 3 to 6 per cent. of moisture; they are very hard, being able to scratch glass or steel, or are 6.0 to 6.5 in hardness, and are very tough and strong. They are sufficiently dense and strong to successfully withstand frost, and are hard and tough enough to wear well under moderate traffic.

" Hard-burned shale brick usually exhibit a very dense, thoroughly homogeneous, compact body that shows complete vitrification; they are practically non-porous, or absorb from 0 to 2 per cent. of moisture; they are extremely hard,—being able to scratch quartz,—they are very strong and tough, and pre-eminently adapted for street paving, if slowly cooled.

" The salmon and building brick are too soft, too porous, and too weak for street-paving purposes. Fire clay paving brick and hard-burned shale brick are both suitable for pavers, and both are vitrified, but the important distinction should be made that one is only incipiently or slightly vitrified, while the other is completely or thoroughly vitrified."

Large Purification Boxes without Water Lutes.

THE water lutes of purification boxes occupy so much space that, where space in gas works is limited, it is desirable to avoid their use. To this end Mr. H. E. Jones, as is stated by *The Gas World* (Oct. 12), erected some purifiers at the Wapping (Eng.) gas-works some 10 years ago, in which a Z-shaped flange and a gasket were made to replace the water lute. Similar purifiers have since been erected at Margate and Eastbourne.

Some enormous purifiers without water lutes have recently been erected by Mr. H. Green at Preston, Eng., of which the following is a description: This set of purifiers is noteworthy, not only because of the absence of water lutes, but also for size. " Some time ago Mr. Green had to face the problem of how to extend his purifying power in a limited space—a problem which falls to the lot of most engineers in the course of their professional career. In this particular instance Mr. Green has solved the problem in a decidedly original way." The boxes measure about 95 ft. by 35 ft. At intervals there are thrown across the box iron plates or girders 2 ft. broad, and between these there are covers of lids about 10 ft. square, fixed down gas tight with a dry jointing material, and lying almost flush with the cross plates. Consequently, when the covers are in position, the whole surface of 95 ft. by 35 ft. is almost flat, and, when the covers are removed, the whole makes one open-topped box, with the exception of the 2-ft. cross plates. The box is supported on girders, with a cellar beneath, for the reception of the waste purifying material. Beneath some of the lids, in the bottom of the box, there are shoots closed by plugs. Then the cover is raised, the plug is drawn out from the top, and the material on the adjacent sieves is shoveled to and down the shoot into the cellar. By adopting this system Mr. Green has saved about 30 per cent. in iron, and also a considerable amount of space. The covers, being small in size, and without the deep flanges required with the water lute, are comparatively light, and can therefore be raised with great ease and speed, the saving of labor in this respect being very considerable. The facility with which the saturated material can be discharged through the shoots also results in a reduction of the labor bill. In the charging of the boxes the cross plates serve as gangways for the men engaged in the work. Each box contains about 150 tons of material, and they have been running for over 18 months without charge.

"It would appear that huge boxes have given every satisfaction at Preston ; but whether they can be recommended under all circumstances is doubtful. For one thing, with boxes of this enormous size it is apparent that a large part of the purifying plant must be put out of action when a change of material has to be made ; and in many cases this may be against the system. It is also doubtful whether the sequence of chemical reactions that are necessary to compliance with the 'sulphur clauses' can be obtained so easily on this large scale as with boxes of less magnitude. Still, the experiment that Mr. Green is making merits the attention of the profession, and especially of those whose make is getting beyond the capabilities of the ground at their disposal."

A 60-In. Steel Conduit.

A FINE example of trench and conduit work is in progress at Allegheny, Pa. This steel conduit is to be 60 in. in diameter and 10 miles long, and will convey water to the city from an intake at Montrose on the Allegheny river. *Engineering News* (Oct. 10) prints an elaborate illustrated description of this important engineering work, from the pen of a member of its staff who visited it. The conduit was designed by Mr. Robert Swan, supervising engineer, and, when completed, will supply 50,000,000 gals. per day to the city.

"The contract for the pipe line was let to T. A. & R. G. Gillespie, of Pittsburg, Pa., at $850,000, this contract including the pipe, valves, specials, and pipe-laying complete. The pumping station is being built by the Jutte & Foley Co., of Pittsburg, and will be equipped with three compound, condensing, high-duty pumping engines, each of 12,000,000 gals. daily capacity, for which the Groshon High-Duty Pumping Engine Co., of New York city, has the contract. The foundations for the pumping station are in very soft and treacherous material, and the walls have been carried down 55 ft. to a thickness of 24 ft. at the base. The trench for the pipe line is largely in a sandy gravel, but also passes through rock and various material. The backfilling was originally specified to be done with moist earth in layers 6 in. deep, each thoroughly tamped, pounded, and rammed. In practice the backfilling is tamped underneath and over the pipe, and then from the top of the pipe to the surface the trench is filled by the 'Little Giant' road steam shovel," described and illustrated in our department of "Improved Machinery and Appliances" for November, and built by the Vulcan Iron Works of Toledo, Ohio.

The pipe is of soft open-hearth steel, having a tensile strength of from 55,000 to 65,000 lbs. per sq. in.; elastic limit, 32,000 lbs. ; elongation, 25 per cent. longitudinally in the direction of rolling, and 22 per cent. transversely; reduction of area, 50 per cent. . . . The steel is specified not to contain more than 0.05 per cent. of either sulphur, phosphorus, or silica, and 0.05 per cent of manganese. The carbon is not specified, and it is limited by the physical requirements.

" The plates must allow cold scarfing to a fine edge without signs of fracture. Shop rivets are open-hearth soft-steel, of the same chemical composition as the plates."

" The pipe is made up in the shop in lengths of four courses, inside and outside course alternating, the longitudinal seams not less than 12 or more than 30 in. apart. In the trench the pipe line is laid so that the longitudinal seams of all inside courses (except curves and angles) are in line and have the calking edges facing upward. For angles and curves the outside courses must be punched so as to form the proper angles, or as many circular seams as may be required, no angle greater than 2½ deg. being made at any one circular seam. The outside courses may have their seams at either side on the upper half of the pipe, but must have the calking edges facing upward. These special or curve pipes may be made no less than four sheets and in sheets less than 6 ft. wide, if deemed necessary. Reducers and taper courses must have the plates so cut and punched that the pitch lines of the rivets in the circular seams are parallel to each other and perpendicular to the axis of the pipe.

" The edges of all plates are planed to the proper lines, and beveled for calking all around, no beveling by shearing being allowed. The pipe is calked at all seams and joints, inside and outside, before any protection coating is applied. At the laps the thickness of the plates is reduced to a fine edge by hammering, and this thin portion has two long rivets. All field and shop calking is what is known as Connery's concave calking, no split calking being allowed."

It will take 3500 tons of ½-in. steel plates to construct this pipe. The edges of the plates are planed to a bevel of 63° with the flat sides, and, after riveting, the edges are caulked as in boiler work. After this the pipes are japaned by the Sabine process.

Injury to Pipes by Electrolytic Action.

THE following is a summary of the results of investigation made by Messrs. Stone and Webster, consulting experts, and printed in the annual report of Mr. Wm. Jackson, the city engineer of Boston. " In certain places throughout the city electrolytic action is taking place ; pipes have already been more or less injured, and are subject to premature decay. Excavations which have been made about the city for the purpose of inspecting the pipes have given only negative results, revealing no marked action, and yet not proving that the natural decay has not been accelerated by electrolysis. Action of a serious nature is confined to special localities, where, owing to certain conditions of the railway system, abnormal currents are flowing through the earth ; but as a whole, the action has been reduced to so small an amount that it is now difficult to detect. In the places where action is found, special precautions in provision of return feeders, and connections with the piping system by the street railway company, will ordinarily reduce the difficulty to a small amount. It is impracticable to entirely eliminate electrolytic action, but, by a constant inspection of the water system as a whole, with a view of locating points where difficulty is liable to occur, and applying such remedies as are well known, the danger can be reduced to a minimum.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Gas Supply.

*1917. The Dvorkovitz Oil Gas Enrichment Process at Bradford (Mr. Wright's first report ; Mr. Wood's report on the working from Feb. 4 to March 9, 1895 ; Mr. Dvorkovitz reply to Mr. Wood's report ; Mr. Shaw's letter to the "Bradford Observer" ; Messrs. Newbigging and Son's report to Mr. Smith ; reply by Mr. Cowgill ; Mr. Wright's replies to Mr. Wood and Messrs. Newbigging). Jour Gas Lgt–Oct. 1. 9000 w.

*2009. The Bradford Oil-Gas Controversy (A continuation of the history of this dispute, consisting of letters from Messrs. Newbigging, Mr. Wright and Messrs. Wood). Gas Wld–Oct. 5. 9000 w.

2029. Acetylene at Work. Ill. (An account of the preparations for business of the Acetylene Light, Heat, and Power Co. of Philadelphia, with notes on the use and advantages of acetylene). Pro Age–Oct. 15. 1200 w.

2030. The Gas Ice-Factory at Newport, R. I. Ill. (The object of the article is to convey a clear idea of the ice-factory in question and of its relation to the gas-industry in general. It first explains of what the manufacture of ice consists). Pro Age-Oct. 15. 2900 w.

*2042. On the Encouragement of the Small Consumer. J. Holliday, with discussion by members (The ground is taken that small consumers will always form the most important part of the patronage of gas companies, and that class of consumers can be materially increased by a liberal policy. The coin meters have already effected this to a noticeable extent). Jour Gas Lgt-Oct. 8. 6000 w.

*2101. Purification at Preston (Describes a set of purifiers of extraordinary size and without water lutes. The experiment merits the attention of gas engineers who suffer for want of room). Gas Wld-Oct. 12. 800 w.

*2105. Blackburn Corporation Gas Works (Deals with results and does not enter upon details of plant). Gas Eng's Mag-Oct. 10. 1100 w.

*2106. Standardizing of Meter Unions. F. Napier Myers (Read before the N. Brit. Asso. of Gas Managers. Points out the advantages that would arise from the adoption of such a standard and advocates a combined effort to secure it). Gas Eng's Mag-Oct. 10. 1200 w.

*2136. Questions Concerning Prepayment Meters (Review of a discussion which followed the reading of a paper on the subject before the North of England Gas Manufacturers' Association). Jour Gas Lgt-Oct. 15. 900 w.

2232. The Creation of a Healthy Public Sentiment toward the Gas Company in the Locality in which it Operates. W. H. Rogers (Read before the 23d annual meeting of the Am. Gas Lgt. Asso. How to treat customers. The policy to adopt in dealing with complaints, etc. Discussion). Am Gas Lgt Jour-Oct. 28. 5000 w.

2233. Retort House Design and Practice. A. E. Forstall (How to design, build and run a retort house. An eminently practical paper, read before the Am. Gas Lgt. Asso., with an appendix giving list of tools necessary for best practice and discussion). Am Gas Lgt Jour-Oct. 28. 7000 w.

2234. Obtaining Cyanogen or its Compounds from the Gases Resulting from the Dry Distillation of Substances of Organic Origin (Complete description of a process invented by H. Dreshchmidt, of Berlin, and patented in England). Am Gas Lgt Jour-Oct. 28. 2200 w.

2367. Laying a Submerged Gas Main (Illustrated detailed description of the submerged main across the Harlem ship canal at Kings Bridge, New York City. Depth of submergence, about 20 ft.) Eng Rec-Nov. 2. 1300 w.

Sewerage.

*2031. Construction of a Sewage Irrigation Plant (The application of sewage to land recommended, and plant described). Dom Engng-Oct. 900 w.

†2187. The Ventilation of Sewers. W. F. Van Buskirk (An argument in support of the theory that disease germs may be transported by sewer air. Short discussion). Eng Soc of School of Prac Sci-No. 8. 1400 w.

†2193. Sewage Disposal in Ontario. R. W. Thomson (A discussion of the feasibility and desirability of adopting the system of filtration and application of the filtered sewage to land, for the sewage of Ontario. Results of the system in other cities reviewed). Eng Soc of School of Prac Sci-No. 8. 2500 w.

2240. Present European Practice in Regard to Sewage Disposal. Allen Hazen (Paper read before the Boston Soc. of Civ. Eng. A general review of the subject including a statement of the problems in sewage purification, and the methods by which these have been met, and wholly or partially solved by engineers in different cities). Eng News-Oct. 24. 4500 w.

†2433. Sewage and Garbage Disposal at Manchester, England. From consular report to State Department. William F. Grinnell, Consul (The sewers of the city are diverted to the outfall works, 5 miles below the city. The cardinal object was to avoid pumping, if possible, and this has been accomplished, the whole drainage finding its way by gravity. The dry refuse is used on the "Carrington moss estate" with great success). San-Nov. 2400 w.

Streets and Pavements

*2346. Requirements in the Manufacture of Paving Brick and Sewer Pipe. Heinrich Ries (Condensed from an article on "Technology of the Clay Industry" to appear in the annual report of the United States Geological Survey. Discusses mixtures of clays which give best results, temperature at which vitrification begins, preparation of clay for mixing pug-mills, stiff mund machines, drying floors, sewer-pipe floors, chamber dryers, progressive dryers, absorptive power of paving bricks, crushing strength, glazing of sewer pipes, &c). Pav & Mun Eng-Nov. 6000 w.

*2347. Production and Importation of Asphalt. E. W. Parker (Condensed from special advance sheets of the annual report on mineral resources by the United States Geological Survey). Pav & Mun Eng-Nov. 350 w.

2416. How to make a Good Paving Brick. M. F. Ellis (Treating of paving brick, its qualities of clays and the best mode of its manufacture). Brick-Nov. 1800 w.

Water Supply.

*1887. Investigation of Public Water Supplies. Floyd Davis (A sanitary classification of potable waters and of the tests thereof, and a statement of the purposes of these tests). Eng Mag-Dec. 3600 w.

1921. Sixty-Inch Steel Conduit for the Water-Works of Allegheny, Pa. Ill. (Description of a very important and extensive piece of trench and conduit work in which the excavation and most of the backfilling is done by the "Little Giant" steam shovel, manufactured by the Vulcan Iron Works, of Toledo, O. The pipe is of steel riveted and in laying is subjected in places to both vertical and horizontal curvature). Eng News-Oct. 10. 2800 w.

†1933. Filters. From *The Practitioner* (A consideration of the precautions necessary to make filtration not only capable of straining and chemical purification, but capable of arresting disease germs). Sanitarian–Oct. 2000 w.

*1947. Metropolitan Water Supply (A consideration of the supply for London, and its need of enlargement. The sources of supply to which attention is directed). Arch, Lond–Oct. 4. 2200 w.

1960. Water Consumption in Chicago. Fred De Land (Daily consumption 149 gallons per capita. Unnecessary waste and leakage considered. Comparison with other cities in this and foreign countries. The waste a matter of individual responsibility). Elec Engng–Oct. 1800 w.

1999. Cincinnati's Water Department (Ill. (Extracts from report of Supt. Willis T. Thorp, with illustrations of some of the costly towers and buildings erected for the use of the department). Fire & Water–Oct. 12. 500 w.

2010. The Use of Sea Water for Municipal Purposes. Francis J. Allen (Recommending the use of sea water for flushing drains, sewers, &c., where there is an insufficient supply of water. The objections stated and proved groundless and the subject thoroughly discussed). Plumb & Dec–Oct. 1. 2800 w.

2092. Sand Washing at the Hamburg Filter Works (Illustrated description of process and plant). Eng Rec–Oct. 19. 1100 w.

2094. Filtration and Leakage Through Large Reservoirs. Ill. (Abstract from a paper read in Paris, on "Precautions to Take in the Construction of Great Reservoirs for Water," by M. Dutoit. Describes methods adopted in the construction of the most recent Paris reservoir, to prevent damage to foundations, &c., by infiltrations, and methods in use in that city to maintain efficiency of reservoirs notwithstanding cracks). Eng Rec–Oct. 19 1200 w.

*2108. The Relative Value of Percolation Gauges. R. E. Middleton (Abstract of paper read before the Soc. of Eng., England. An investigation of the reliability of percolators in which four different ones were critically examined. Records are very contradictory). Ind & Ir–Oct. 11. Serial. 1st part. 3000 w.

*2170. London Water (Editorial review of the report of the chief engineer of the London County Council, with map showing available sources of supply). Engng–Oct. 18. 2500 w.

2223. Inclosed Standpipe, St. Charles, Mo. (Abstract of a paper read June 5, by Edward Flood before the Engineer's Club of St. Louis, Mo. Besides describing and illustrating details of construction of the stand-pipe named, the paper deals with the general subject of standpipe construction, and causes of failure to be guarded against). Fire & Water–Oct. 26. 1500 w.

*2325. Metropolitan Water Supply (A critique of the scheme of the water committee of the county council of London, which proposes to supply London with water from the highlands in the south of Wales). Engng–Oct. 25. 3300 w.

2405.—75 cts. Electrolysis. H. A. Storrs (Paper read before the New England Water Works Association, Sept. 11, 1095. Practical information gleaned from technical publications and arranged under three different heads. (*a*) Remedies in case of cities where electric roads are already in operation. (*b*) Preventive measures for cities where roads are yet to be installed. (*c*) Some of the legal aspects of the subject. Discussion by members). Jour of N Eng Water Works Asso–Sept. 5500 w.

2407.—75 cts. Water Supply of Lynn, Mass. John C. Haskell (Paper read before the New Eng. Water Works Asso., Sept. 11, 1895. A detailed description without illustrations. Some of the points described are of interest to water works engineers and officials. Discussion). Jour New Eng Water Works Asso–Sept. 3500 w.

2408.—75 cts. A Short History of the Manchester High Service. Ill. Charles K. Walker (Paper read before the New Eng. Water Works Asso., Sept. 13, 1895. Includes not only an account of the initiation of this service and conditions leading to it, but also describes it). Jour N Eng Water Works Asso–Sept. 2000 w.

Miscellany.

*1952. The Prevention of Fires in Theatres. Ed. O. Sachs (From a paper introductory to a discussion at the Fire Congress held at Amsterdam. The author advises 1, planning; 2, watching; 3, inspection; 4, construction). Brit Arch–Oct. 4. 1100 w.

*2018. Municipal Ownership of Street Railway. I. Edward W. Bemis. II. Hartio A. Foster (The writers think, with the present spoils system, the immediate results might not be any great improvement; the ultimate results appear to favor such ownership. Reasons for this view are given). Elec Pow–Nov. 2500 w.

2035. The Proposed New Drainage System of New Orleans (Full description with map of a long needed work presenting unusual dfficulties). Tradesman–Oct. 15. 2800 w.

†2274. The Municipal Spirit in England. Robert P. Porter (An account of the changes that have taken place in the governing of the cities of England and Scotland and the system in London to day, with the prediction that town life of the 20th century will be as widely different from the 19th as this century differs from the 15th). N Amer Rev–Nov. 5000 w.

*2337. Recent Progress of Italian Cities. Albert Shaw (An interesting account of the Italian cities, their modern aspects, municipal system, sanitary laws, government, thoroughfares, street railways, gas supplies, water supplies, school system, building regulations, &c., &c.). Rev of Rev–Nov. 14000 w.

*2344. General Suggestions as to Parks and their Management. Edward Hill (Considers briefly the selection of site, method of procedure in surveying and designing as well as general management). Pav & Mun Eng–Nov. 1500 w.

*2345. The Park System of Boston. Sylvester Baxter (Condensed from the Boston Park Guide, written by Mr. Baxter. Description of the different parks and special features of each, with excellent half-tone illustrations). Pav & Mun Eng–Nov. 3000 w.

RAILROADING

The Train Speed Record Broken.

THOUGH the late record made by the N.Y. C. & H. R. R. R., in the run from New York city to Buffalo, was at a higher rate of speed than was made by either of the English roads in their competition, yet the excuse was given that the distance was less. The last run made by the Lake Shore and Michigan Southern Railway from South Chicago to Buffalo settled this point in a very satisfactory manner, breaking all previous records. *The Railway Review* (Oct. 26), in describing the run, says that this phenomenal trip "from South Chicago to Buffalo, 510.1 miles, at the rate of 63.614 miles per hour, including all stops, and at the rate of 65.073 miles per hour, excluding stops," was made by a special train of three cars. The engines selected were four 17 × 24-in. 8-wheel, and one 17 × 24-in. 10-wheel (with 5 ft. 6 in. drivers), each of the former weighing 104,000 lbs. with 80,000-lb. tender and having 65,000 lbs. on the drivers, while the weight of the latter was 114,000 lbs. "The train was composed of two parlor cars, weighing 92,500 lbs. each, and Dr. Webb's private car, weighing 119,500 lbs., making the total weight of the train back of the tender 304,500 lbs., or 152¼ tons." The passengers were principally officials of the road, who made accurate records of time and other items of interest.

The following summary gives the speeds over the several divisions:

			Miles	Av. running speed
Western Division			87.4	61.38
Air Line	"		133.4	64.25
Toledo	"		107.8	60,96
Eastern	"	1st half	95.5	67.01
"	"	2nd "	86.0	72.94
Total, Chicago to Buffalo			510.1	65.07

Less time was required in changing engines than would have been consumed in stopping to take water and coal. The changes were made in the times given in order: 2 min. 11 sec., 2 min. 28 sec., 1 min. 25 sec., and 2 min. 18 sec. There was also one flag stop of 2 min. 5 sec.

The trip over the last division is thus described: "At Erie a ten-wheeled engine was coupled on. This engine, No. 564, has 17 × 24-in. cylinders and drivers only 5 ft. 6 in. in diameter, but, if those who were watching the speed so closely had any misgivings as to the ability of such an engine to make fast time, they were soon set at rest. Engineer Tunkey, who handled the throttle on this division, said he was going to make a record, and he did it. . . . . The average speed on this division reached the remarkable figure of 72.91 miles per hour. But this does not tell the whole story, for 1 mile was made at the rate of 90 miles per hour, another at the rate of 92.3 miles per hour, and 33 consecutive miles were passed over at the average rate of 80.4 miles per hour. The total time from South Chicago to Buffalo Creek was 8 hours 1 min. 7 sec., and, as the total distance is 510.1 miles, the average speed is 63.614 miles per hour. The four regular and one flag stop sums up 10 minutes and 47 seconds; deducting this from the total time leaves 7 hours 5 minutes and 20 seconds as the actual running time. This makes the running speed 65.073 miles per hour, which is considerably greater than for any other long-distance run."

Racing Across the Continent.

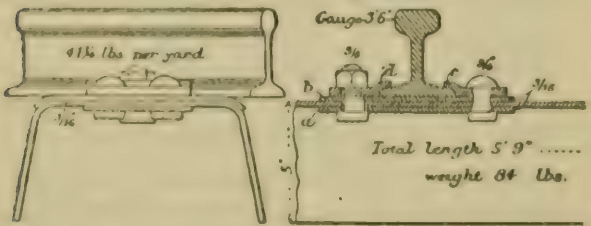
APROPOS of the recent record-breaking feats in 500-mile runs comes the news from the progressive "West" of big reductions in time on the Chicago-San Francisco routes. According to the *Railway Age* (Nov. 1), the Southern Pacific proposes to increase its mile-per-hour rate from 33⅓ to 34½ miles. "And now comes the Santa Fé route into the field, with a California limited train service, running daily, which at one stroke cut off 12 hours from its previous schedule. . . . . As the course crosses four mountain ranges with long and heavy up-grades,—one stretch of 15 miles averaging nearly 175 ft. to the mile, and another of 25 miles averaging over 92 ft. to the mile, with others of less difficulty —it will be seen that to maintain such an average speed (30½ m. p. h.) means a far higher rate over favorable ground." It is stated that the Union and Central Pacific will join the race by cutting off 12 hours of its time. To show how the three great transcontinental routes to Los Angeles and San Francisco compare in distance and speed the following tabulated statement is presented.

	To Los Angeles.			To S. Francisco.		
	Miles.	Hrs.	Av.	Miles.	Hrs.	Av.
Santa Fé........	2265	74	30.5	2577	....	...
Southern Pacific	2007	58	34.5	2489	75	33⅓
Union Pacific (via C. & N.-W.)	2712	106¾	25.4	2357	85¼	27.6

Steel Sleepers.

STEEL is the metal of the present, and, as economy in manufacture has made cheapness possible, we may look for its application to all construction where strength and wear are desirable considerations. Its application to railway work is increasing rapidly in rolling stock, signal, station, and permanent way construction. As an example of the latter, the *Iron and Steel Trades Journal* (Sept. 28) gives a description of the construction of the Normanton-Croydon Railway, North Queensland, in an excerpt from a paper by Mr. J. A. Griffiths, read before the Institution of Civil Engineers. The road is 94 miles in length, constructed in two sections. "The sleepers for the first section are herewith shown in Fig. 1. The body was bent cold from a $\frac{8}{16}$-in. plate, and was strengthened inside and outside at the rail seats by plates *a* and *b* of the same thickness. The outer fixed clips *c*, determining the gage of 3 ft. 6 in., are attached by two ¾-in. rivets, and the inner removable clips *d* by a single ¾-in. bolt with a grip-nut and pear-shaped neck fitting into corresponding holes in the trough-plates." The steel plates made in England by the Tredegar Ironworks were shipped to Brisbane. The plates were punched, cut, shaped, and prepared for laying, in the colony. The total number bent was 80,605, of 84 lbs. each. When finished, they were dipped in a boiling mixture of gas-tar and Trinidad bitumen. The fuel cost per sleeper (unnecessarily high) was:

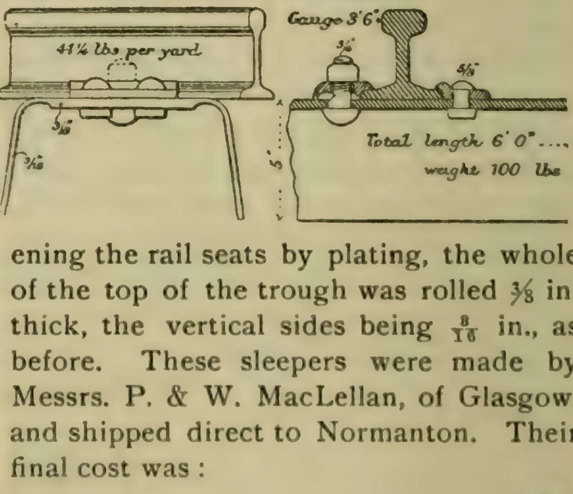
Figs. 1.



	d.
Imported materials, including plates, bars, and bolts........	53.62
Freight and charges, England to Brisbane	8.28
Toowoomba Foundry Company's contract for forming, providing rivets, and coating	21.50
Freight and lighterage, Brisbane to Normanton	22.27
Compensation for defective materials, &c.	2.94
" to shipping contractors...	1.93
Total cost.........................	110.54

The sleepers used on the second section were slightly longer and heavier than those for the first section, the actual dimensions being shown in Fig. 2. Instead of strengthening the rail seats by plating, the whole of the top of the trough was rolled ⅜ in. thick, the vertical sides being $\frac{8}{16}$ in., as before. These sleepers were made by Messrs. P. & W. MacLellan, of Glasgow, and shipped direct to Normanton. Their final cost was:

Figs. 2.



	d.
Messrs. P. and W. MacLellan's contract.	90.00
Freight, lighterage, and charges........	30.05
Total..............	120.05

The cost of preparation in Scotland was probably increased by substituting hot for cold pressing. Under more favorable conditions, steel sleepers of these patterns could probably be delivered at an Australian port for about the following prices. And these costs would admit of still further reduction in case of larger contracts.

Weight of tie	84 lb.	100 lb.
Steel at ½d per lb.	42d.	50d.
Forming and coating	21 "	18 "
Freight	9 "	10 "
Total	72	78 "

It was intended that the sleepers should penetrate to half their depth below the original surface. The rate of progress in laying the steel sleepers on the first section was 5 miles per month, while on the second section it was 6 miles per month. The average progress per day was thirty-two chains, with a maximum of fifty-two chains. The average cost of the work in the earlier stages was £71 6s. 6d. per mile; when fifty-two chains per day were laid, the cost was reduced to £58 13s. 4d. per mile. It must be remembered that the gage was 3 ft. 6 in., and that very little excavation or embankment was required. In contrast with these figures, the cost of laying the short portions, including switches with wooden sleepers, was nearly 50 per cent. greater for labor, with the additional disadvantage of the future cost of relaying the wooden sleepers probably from five to six times during the life of the steel sleepers. The total cost of the railway is estimated at £2162 per mile for materials used, labor in construction, surveys, plans, and supervision.

In time of floods, it was found that the steel sleepers gave less trouble than wooden ties; 139 of the latter were renewed at the end of 3 years, on account of decay and the damage caused by white ants.

" The cost of maintenance for each season since the opening of the line, as given in the official returns, shows a steady decrease to a minimum of under £62 per mile per annum," and, comparing this with statistics from other roads, the author concludes that " it is probable that, in similar circumstances, the maintenance of the steel-sleeper road would be half, or less than half, that of a wooden-sleeper road." Corrosion has been small in amount, even where the line crosses a salt-water swamp. Altogether, the type of construction seems to be entirely satisfactory in this particular case.

The Fastest Train Runs.

SINCE the train speed record has been again broken, it is a matter of interest to know how the conditions in the several cases compared. *The Railway Master Mechanic* (Nov.) has made a tabulated summary, which is given below, and introduced it by saying that " so much that is inaccurate has been published regarding these recent fast runs that our readers will be interested in a comparison of the three, which we have endeavored to put in tabular form."

	Lake Shore & Mich. South.	N. Y. Central & H. R. R.	West Coast Route.
Date	Oct. 24, 1895.	Sept. 11, 1895.	Aug. 22-23, '95
No. of cars	3	4	3
Weight of cars	304,500	358,310 lbs.	150,080
Starting point	100th St., Chicago	New York	London
Finish	B'ffalo Creek	East Buffalo	Aberdeen
Total distance in miles	510.1	436.32	539.75
Total time in minutes and seconds	481 m. 7 s.	411 m. 56 s.	512 m.
Average speed in miles per hour	63.614	63.55	63.25
Total time in motion	470 m. 20 s.	407 m. 41 s.	505 m.
Average speed, deducting stops	65.07	64.22	64.12
Length of division on which fastest average speed was made	86	145.6	141.25
Average speed on said division	72.92	65.75	67.50

The Railroad Gazette (Nov.) gives a more detailed statement, agreeing in the main with the above, except as to the item " Average speed deducting stops " on the West Coast route, which it gives as 63 93, instead of 64.12 as above stated.

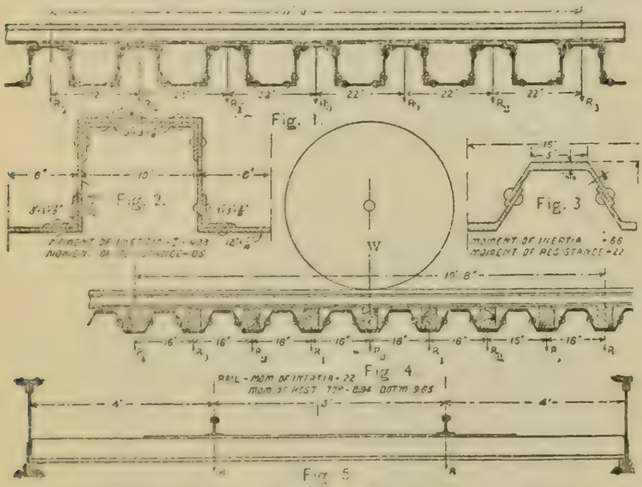
Solid Floors for Railroad Bridges.

" THE practice in the use of solid floors in railroad bridges is extending in the United States quite as rapidly as one could expect. The theory has spread considerably faster than the practice, until now the objections which were heard only 5 years ago are seldom raised, and the advantages are pretty generally admitted." This is from *The Railroad Gazette* (Oct. 25), which gives an abstract from a paper by Mr. Henry Goldmark, read before the Western Society of Engineers and published in the

Jour. Assn. Eng. Societies. The chief advantage of the new system of construction is the absence of the liability of vibration or deflection. "A number of American roads have, within the past few years, begun the construction of solid or continuous floors of iron or steel, such as have been used for many years in England. These consist, as a rule, of a series of troughs running transversely to the main girders, to which they are fastened. In some cases beams replace troughs, the beams being closely spaced and covered by a continuous steel plate, often with a ballast filling and timber cross-ties. Mr. Goldmark makes a calculation of the distribution of a single concentrated load throughout the different troughs of two types of floor system. The problem consists in finding out what proportion W is carried by the different troughs, so that, when this is known, the strains on the troughs and rails may be computed by the ordinary theory of beams. The following equations are deduced for the types of flooring shown.

Figs. 1 and 2.	*Fig. 4.*
$R_0 = .39\ W$	$R_0 = .192\ W$
$R_1 = .26\ W$	$R_1 = .173\ W$
$R_2 = .09\ W$	$R_2 = .120\ W$
$R_3 = -.045\ W$	$R_3 = .080\ W$
	$R_4 = .031\ W$

"The various reactions are represented by the letter R, with varying sub-letters, as shown in the engraving. Having thus obtained the proportion of a single concentrated load carried by the different troughs, calculations may readily be extended to any system of axle loads desired. By combining the percentages of W thus concentrated on the different troughs, we find that the distribution of the load over all the troughs of the floor will be nearly uniform. These results enable us to compute the greatest strains likely to occur in any one trough with a degree of accuracy fairly comparable with that obtained in the other parts of bridges. The point as to the effect of an inefficient rail joint on the distribution of the load has been raised. Some computations have been made by the author with the joint plates supposed to be entirely removed. The results indicated that even in this case the maximum load on a trough is but slightly increased over the proportions tabulated above.



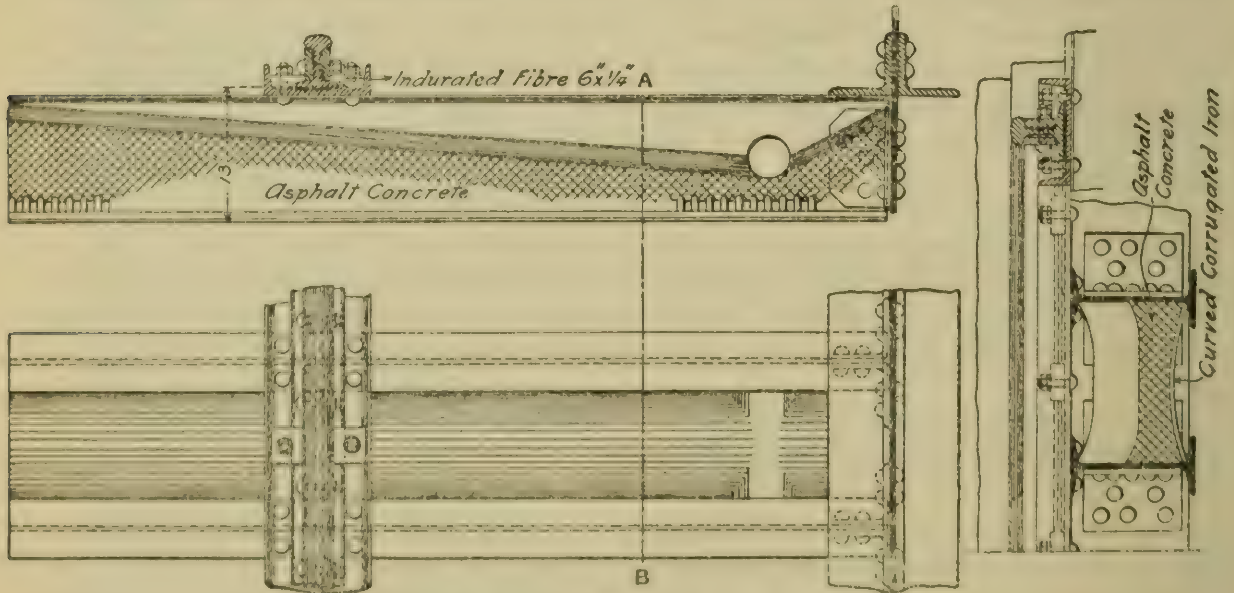


Fig. 6.—Horton's Solid Bridge Floor.

" Fig. 6 illustrates a floor designed by

Mr. H. E. Horton, which has many excellent features, as inspection will indicate. Indurated fibre is placed between the rails and the channels, as shown, and it is well drained."

Economy in Car Lubrication.

In the appendix to a book on " Car Lubrication " by W. E. Hall will be found a series of tests made upon the Paris, Lyons & Mediterranean Railway, which *The Railway Review* (Nov. 2) quotes from as follows :

" Lubricating Wicks.—The tests made to compare the woollen wicks with those of cotton, in regard to the facility with which they supply the oil, have shown a superiority of delivery of from 50 per cent. to 100 per cent. in favor of the woollen wicks. It was also found that the renewals of the woollen wicks were only 68 in number compared to 100 of the cotton ones, and that the woollen wicks were less liable to firing. Notwsthstanding the higher price of the woollen wicks, it was found economical to use them, and since May, 1893, the Paris, Lyons & Mediterranean Company have adopted them entirely.

" Bearings.—The result of the tests made showed that the wear of white-metal bearings was 50 per cent. less than in the case of bronze bearings. The tests also showed that, by the use of white-metal bearings, a diminution of 20 per cent. on the resistance of fully-loaded coal wagons, forming trains weighing 500 tons, traveling at speeds of 16 miles to 26 miles an hour, was given ; that, as the speed increased, this gain was diminished, but remained always 5 per cent. less. As a consequence of these tests, the Paris, Lyons & Mediterranean Company, in 1893, abandoned the use of bronze bearings for carriages and wagons, and adopted white-metal bearings.

" Lubricants.—The tests made by abandoning carriages to themselves on a gradient have fully justified the rejection of grease by nearly all the railway companies, and the adoption of oil. Grease gave, for carriages isolated and mounted on bronze bearings, an increase of resistance per ton of :

" 25 per cent. in comparison to mineral oil at low speeds (19 miles an hour) ;

" 40 per cent. in comparison to colza-oil at low speeds (19 miles an hour) ;

" 3 per cent. in comparison to mineral oil at high speeds (38 miles an hour) ;

" 14 per cent. in comparison to colza-oil at high speeds (38 miles an hour).

" The increase of resistance would be greater in ordinary trains than indicated above for isolated carriages. From these same tests, combined with those made by means of the dynamometer cars, it was found, in comparing colza-oil, mineral oil, and mixtures of these two, that colza oil is more advantageous than mineral oil, and that the mixtures are classed between the two. Taking white-metal bearings, colza-oil, with an addition of 10 per cent. of shale oil, appeared to be very nearly equal to pure colza-oil in relation to non-resistance to traction ; pure mineral oil gave, in relation to pure colza-oil, an increase of resistance per ton of 15 per cent. for trains of 300 tons, composed of fully-loaded coal wagons, and running at speeds of 16 miles to 26 miles an hour. The mixtures of mineral and colza-oil gave more resistance than pure colza-oil, and the increases of resistance were, in the same trains :

" 13 per cent. for the mixture of 75 per cent. of mineral oil and 25 per cent. of colza-oil ;

" 7 per cent. for the mixture of 50 per cent. of mineral oil and 50 per cent. of colza-oil ;

" 3 per cent. for the mixture of 25 per cent. of mineral oil and 75 per cent. of colza-oil.

" It was also found that in summer the consumption of colza oil was only 0.8 of that of mineral oil. The tests were not made in winter, but it is presumed that then the consumption of mineral oil would be less. As a result of the tests, the Paris, Lyons & Mediterranean Company abandoned in 1891 the use of mineral oil, and adopted exclusively colza-oil with an addition of 10 per cent. of shale oil, the latter having the advantage of thickening less at a low temperature. The author estimates that in round numbers his company spent in 1890 $3,200,000 in coal for the traction of their trains, and used 766 tons of lubricants. If mineral oil had been used in place of colza-oil, $320,000 more would have been expended on coal, and $61,250 less on oil, thus justifying, on the side of economy, the choice of colza-oil. Colza-oil is dark in color, and is sometimes known as rape-seed oil."

The Abolition of Fast Freight Lines.

As an editorial opinion on one of the means of simplying and economizing in railway freight service, the following is taken from *The Railway Review* (Sept. 28).

"The reported clause in the railroad presidents' agreement regarding the abolition of fast freight lines and their army of agents has provoked considerable comment, the burden of which appears to be that railroads cannot be well operated without them. A careful study of the fast freight line system of transportation fails to disclose any real need for their existence. Time was, before the freight business of the country was so organized as to permit of through shipments over connecting lines, as is now so common, when such organization filled a useful place. As compared with ordinary transportation by rail, they really were 'fast' freight lines. Through billing was an unknown quantity prior to the introduction of this system, and the delay incident to the transfer and re-billing of all freight at junction points was thereby obviated. But at the present time there is no difference in the rate of speed, or, so far as the movement itself is concerned, in any other particular, between property forwarded by fast freight lines, or by the road proper. . . . It should be understood that neither fast freight lines nor their representatives create any business; they simply divide it, and the contention that the roads would lose traffic by their abolition is pure nonsense.

"Perhaps the greatest objection to the fast freight line, aside from the question of rate demoralization, is the expense of maintaining the organization. This amounts to a serious tax upon the business, particularly in view of the low rates which obtain in the territory most largely traversed by these lines. When the average earnings per ton-mile was 2 cents and over, this item constituted but a small percentage, but, now that it is about ½ cent per ton-mile, the burden is too great to be viewed with complacency. Added to the direct expense attaching to this service are several other items, notably that of distributing and holding cars at various shipping points waiting for loads. It is by no means uncommon for a road to be obliged to haul the equipment of some other line 200 to 300 miles for the purpose of moving a shipment contracted *via* that line, when at the same time a half dozen empties of various other lines might be standing upon the side track at the shipping point. In the absence of fast freight line organizations, any available car would be used, provided it was loaded in the 'home' direction. Even under present rules, and in the event of the adoption of a car clearing-house, the car of any road could be employed." The editor deplores the necessity of dispensing with the services of a number of old and faithful employees with the abolition of fast freight organization, but offers the consolation that it would be a necessary action sooner or later.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Technical Journals—See Introductory.

*1890. The Cost of Railroad Construction. John F. Wallace (Analyzing the items of expense incurred in building different types of railroad, and showing the influence of time and circumstance in causing the variations therein. The subject is treated in detail, and includes statistics and tables of cost). Eng Mag-Dec. 3300 w.

†1901. The Street Railway Systems of Canada (Handsomely illustrated description of the Canadian roads, in the souvenir edition, issued on the occasion of the meeting of the American Street Railway Association, at Montreal, Can). St Ry Jour-Oct. 20000 w.

†1902. From Atlanta to Montreal.—A His-

tory of the Year. Ill. (Improvements in street railway practice during the past year, in the several cities of the United States, with numerous cuts illustrating new track construction and underground electric conduits). St Ry Jour-Oct. 4000 w.

†1904. Electric and Cable Car Trucks (Plan and side elevation drawings of both types, with some very interesting notes on their practical working). St Ry Jour-Oct. 3600 w.

†1905. Some Good Points in Car Building (Standards used by the J. B. Brill Co. Short description with two views of roof and reinforced corner). St Ry Jour-Oct. 1200 w.

*1908. Steel Sleepers in Queensland. John Alfred Griffiths (Excerpt minutes of Pro. of Inst. of Civ. Eng. A detailed description of the steel ties used, their manufacture, laying in place, cost of laying and maintenance and wear during five years). Ir & St Tr Jour-Sept. 28. 3800 w.

*1909. Street Railways of Montreal (Historical and descriptive. The special convention edition, printed in colors and handsomely illustrated). St Ry Rev-Oct. 6500 w.

*1910. Buffalo and Niagara Falls Electric Railway (Important inter-urban undertaking—built for heavy traffic and high speed. Description of plant and equipment, well illustrated). St Ry Rev-Oct. 2000 w.

*1911. The Mount Hamilton Incline Railroad at Hamilton, Ont. John Fensome (A counterbalanced 12-ft. gage railway, on a 45% grade. well illustrated by views and with detail specification). St Ry Rev-Oct. 1400 w.

1922. The Popp-Conti Compressed-Air Conduit System for Street Railways (Consists of a compressed air pipe between the tracks, having discharge mechanism at regular intervals, from which the air is fed in a few seconds stop, into the car reservoir, propelling car through a two-cylinder compound engine. Originated in Paris). Eng News-Oct. 10. 500 w.

1926. Cable Incline Railways of the World (A valuable article giving details of all the principal inclines in the world and a table giving all figures of interest). Eng News-Oct. 10. 1400 w.

1927. The Long Coal-Car Dumping Machine. Ill. (The car fastened inside a large cylinder, rolls with it and thus empties from the top. Built for the N. Y. P. & O. R. R. at Cleveland). R R Gaz-Oct. 11. 700 w.

1929. Street Railroad Postal Cars (Description of car, with plan and view of Postal Car on 3d Ave. Cable Road, N. Y. City). R R Gaz-Oct. 11. 300 w.

1930. Westinghouse Brake Trials in England (Editorial comment on some brake trials in England, with abstracts from *The Engineer* and *Engineering*). R R Gaz-Oct. 11. 1800 w.

1932. Taunton Sprinklers and Snow Plows for Street Railroads (Description with illustration of each). R R Gaz-Oct. 11. 800 w.

1943. Expanding Railway Earnings (September gross earnings point to a steady expansion in the volume of business done by the railroads. Tabulated statements of the gross earnings of 117 roads for Sept., and of the earnings and mileage for nine months). Bradstreet's -Oct. 12. 2000 w.

1958. A Plea for Electric Railways. Arthur Vaughan Abbott (A review of the mutual relations between the street railways and the public, and its usefulness in making homes possible for the masses considered). Elec Engng-Oct. 7300 w.

1963. The Mt. Clemens Fast Line; an Electric Interurban Road. Ill. (A road uniting Mt. Clemens and Detroit. A description of the road as completed. Portable telephone sets are used, each car being provided with one). Elec Ind-Oct. 700 w.

1979. Ex-Senator Edmunds on the Interstate Commerce Law (Abstract of an interview with ex-senator Edmunds, from the *Chicago Tribune*. It maintains that railways have taken a wrong position in their relations with the Interstate Commerce Commission, and that they know they are wrong. Incidentally it favors pooling). Ry Rev-Oct. 12. 1400 w.

1980. Standard Pilots. Ill. (The pilot adopted on the Chicago & Northwestern Railway, in order to facilitate repairing, as a substitute for the 100 different types in use). Ry Rev-Oct. 12. 1000 w.

1981. Train Shed of Reading Terminal at Philadelphia (Description of the structural peculiarities with section and details). Ry Rev-Oct. 12. 1500 w.

1983 Steel Rails of Heavy Sections Manufactured West of the Alleghenies. Robert W. Hunt (Paper presented to the Am. Inst. of Min. Eng. Showing the results of rigid inspection, and the specifications in full as now used, with some references to the standard rail sections of the Am. Soc. of Civ. Eng.). Ry Rev-Oct. 12. 3000 w.

1995. Ninety Miles an Hour. A New Style of Engine and What is Claimed for it. Ill. (To be placed on the Holman friction-geared trucks. Each of its driving wheels rest upon and between three other wheels that finally rest on the rails. The speed doubled by the use of this truck). Inv Age-Oct. 400 w.

1996. Development of Street Railway Apparatus. A Retrospect. Nelson W. Perry (An article of interest to electric railway men, giving an account of the earliest electric roads with specifications and bids). Elec-Oct. 16. 4300 w.

2002. The Use and Abuse of Transfers. J. B. Cohoon (Advises avoiding the use of transfers wherever and whenever possible. The best form is the limited transfer). Elec Wld-Oct. 19. 1800 w.

*2020. Electrical Details of the Metropolitan Elevated R. R., Chicago. Ill. Hugh Hazelton (A detailed description of the novel electrical features). Elec Pow-Nov. 1100 w.

2023. Organization of the Administrative Force of a Railroad (Extracts from the address of H. S. Haines, Pres. of the Am. Asso., Oct.

16, 1895, advocating the entrusting of considerable discretionary powers in the hands of officials in matters coming under their jurisdiction). R R Gaz-Oct. 18. 2000 w.

2024. Traction Tests on the Northern Pacific (Description of tests, with several diagrams and an inset, showing diagramatically the relation of grade, speed, and fuel to power required and also tests of the friction of various slide and piston valves. These are official tests and are both interesting and instructive). R R Gaz-Oct. 18. 1500 w.

2025. Roadmasters' Association of America (Reports of the committees on "Long Rails and Miter Joints," "Hollow Tires," "Joint Fastenings," "Track Tools," etc., read at the St. Louis meeting. They recommend long rails and miter joints; also that the wear on tires be within ⅛ in. for high speed, and ¼ in. for all other engines, and also the adoption by the association of eight specified track tools as standard). R R Gaz-Oct. 18. 1300 w.

2026. Railroads and Their Employees (A paper presented at the meeting of the Am. Soc. of R. R. Supts., at New York, Oct. 14, by a special committee, C. R. Fitch, chairman. A report recommending careful selection of men, seniority giving place to superiority, strict and impartial but not harsh discipline, a "relief" system, and recreation clubs, but is doubtful as to premiums for good work). R R Gaz-Oct. 18. 1400 w.

2027. Some Facts Concerning the Use of Tie Plates. Benjamin Reece (Indicating that the tie plate is now a fixed factor in track construction, having passed beyond the experimental stage; with figures showing the extent to which the Servis plate has been adopted). R R Gaz-Oct. 18. 500 w.

2040. Changes in the Brooklyn Bridge Railway (Editorial discussion of the new terminal facilities, pointing out many undesirable features and criticising the present and proposed plans for switching and the adoption of electricity). Eng News-Oct. 17. 2400 w.

*2070. The Bristol Electric Tramway. Ill. (Full description. The opening of this tramway is considered important, and it is expected that it will have so important a bearing on the question of electric traction in Great Britain that history of traction in that country will be dated from its inauguration). Elec Rev, Lond-Oct. 11. 4500 w.

*2085. Comparative Advantages of Vignoles and Bullheaded Rails. James Whitestone (Communication advocating the superiority of the bullhead or double headed R. R. rail over the Vignole type of section, and predicting its future adoption). Eng, Lond-Oct. 11. 1200 w.

*2087. Single Driving Wheels in the United States (Editorial discussing the probability of the adoption of these engines on American railroads, giving high speed, small repairs to the large single wheel, but stating that they are not adaptable where starting a train is frequent). Eng, Lond-Oct. 11. 1800 w.

2096. The Joint Traffic Association (Full text of the agreement now under discussion in its present form, proposed for adoption for the various U. S. railways for the sake of uniformity in management). Ry Age-Oct. 18. 2000 w.

2097. The Southern Railway (The Southern Railway building and exhibit at the Atlanta exposition, with a description of the terminal arrangements and the rules governing the "Hall" automatic block system employed). Ry Age-Oct. 18. 2000 w.

*2109. Political Railway Control in New Zealand (Showing that the effects of government control have been quite unsatisfactory, with other facts of interest relating to New Zealand railways). Trans-Oct. 11. 1800 w.

2116. The E. M. Conduit Railway System. Ill. (Consists essentially of a conductor laid in sections flush with the pavement, midway between the rails, which sections are not part of the circuit, and hence are dead under normal conditions; only when a car approaches a section does it become live, remaining so until the car has passed over the section, when the latter is again disconnected from the live feeders and becomes dead; all these operations being performed automatically). Elec Eng-Oct. 23. 1600 w.

2117. Ties and Poles. N. W. L. Brown (Abstract of paper read at the Montreal convention of the A. S R. A. Discusses the kinds of ties and poles in use, and recommends the use of creosoted timber). Elec Eng-Oct. 23. 2500 w.

2118. The Present Status of the Air-Brake. E. J. Wessels (A paper read before the A. S. R. A. at Montreal. The object of the paper is to call attention to air-brakes in general, applicable to passenger and freight, electric and cable cars), Elec Eng-Oct. 23. 2200 w.

†2134. Improved Tubular Bogie Wagon. Ill. (A 22-ton freight car designed for English roads, with special features of design: (1) the frame tubes are of one diameter; (2) all clamps are duplicates; (3) all channels and plates are of one section; (4) there are no special parts; (5) no steel frame exists with a less number of parts; (6) no parts are jointed). Ind & East Eng-Sept. 21. 1500 w.

†2135. Indian Railways, 1894–95 (Editorial. Abstracts from Commissioner Gracey's Administration Report, giving some interesting tabulated statements as to mileage, financial condition, expenses and earnings, with much detailed information). Ind & East Eng-Sept. 21. 1800 w.

2139. A Model Electric Railway Plant (Illustrated description of the plant of the Fairhaven and Westville electric railway). Sci Am-Oct. 26. Serial. 1st part. 1300 w.

2147. Lehigh Valley Wide Firebox Express Locomotive. Ill. (A design possessing many excellent features. Drawings and specifications). R R Gaz-Oct. 25. 800 w.

2148. The Transportation Show at Atlanta (Enumeration of exhibits, with some short descriptions). R R Gaz-Oct. 25. 1600 w.

2149. The Brake Trials on the Northeastern Railway of England (Showing the relation between speed, pressure and coefficient of friction, and comparing it with some American tests). R R Gaz-Oct. 25. 900 w.

2150. September Accidents (A general tabulated summary of accidents classified and compared for the month of September and which resulted in injury to persons). R R Gaz-Oct. 25. 500 w.

†2152. The Electric Railway System of Havre, France. Ill. (The first electric street railway installed in France. It comprises 40 cars, each first and second class, carrying a total of 50 passengers each. First class seats are plush covered, fare 3 cts.; second class of polished pine, fare 2 cts.). St Ry Jour-Nov. 1100 w.

†2153 New Cable Mail Cars for Third Avenue (Description illustrated by an interior and exterior view. There are eight cars in the service making sixty eight trips per day through New York City, facilitating the quickness of distribution of mails). St Ry Jour-Nov. 800 w.

†2154. Coal Handling System of the Buffalo Railway Company. Ill. (An automatic system of coal handling, consisting of four systems of conveyors, a storage tank, a traveling car distributing coal to the mechanical stokers, all operated by electricity. Two men now handle the plant, otherwise requiring 18 coal heavers). St Ry Jour-Nov. 500 w.

†2155. Electric Railway Notes From Europe. Ill. E. J. Wessels (The underground electric street railway under construction at Buda Pesth; a double track road with steel girder roof, handsome stations built of glazed tiles, all lighted by electricity and well ventilated. Also improvements at Halle, Leipsic and Chemnitz). St Ry Jour-Nov. 3000 w.

†2156. Wear of Wheels (Tabulated statements showing causes why street car wheels were removed in one city both for cable and horse propulsion). St Ry Jour-Nov. 500 w.

†2157. Load Diagrams in Boston (Curves showing the relation between amperes and number of cars and hours of the day, by tests on an electric railway). St Ry Jour-Nov. 200 w.

†2158. Report of the Committee on Patents to the American Street Railway Association. F. R. Greene and J. W. McNamara, Committee (Bringing to light the fact that many patents, now commanding royalties, would not be valid if tested, and making recommendations to the association). St Ry Jour-Nov. 2000 w.

†2159. Special Discourse on "Car Heating." Ill. J. F. McElroy (An excellent article on the methods of electric car heating stating among other things, that one person gives off 191 B. T. U. heat per hour). St Ry Jour-Nov. 4000 w.

2161. Number and Classes of Railway Employés (Editorial comment on the report of the statistician for the interstate railway commission, giving an itemized table of the total number of men employed in 1892, 1893 and 1894). Ry Age-Oct. 25. 450 w.

2162. The Fastest Long Distance Run on Record—510 Miles at 64 72 Miles an Hour (Account of a run made by a three car train on the Lake Shore and Michigan Southern Railroad, on Oct. 24, from Chicago to Buffalo). Ry Age-Oct. 25. 1000 w.

2179. The Taylor Motor Car Wheel. Ill. (A cast iron wheel with chilled flange and steel tread. Description of method of manufacture with advantages). Ir Age-Oct. 24. 500 w.

2224. New Terminal Station of the Brooklyn Bridge (History of the Brooklyn terminal station where the bridge cable line, two elevated road lines and the street car lines center, with a defense of the management). Eng Rec-Oct. 29. 1300 w.

2226. The Three Phase Railway System. Ill. (Description of the Lowell & Suburban Railway). Ry Rev-Oct. 26. 1200 w.

2227. Pneumatic Snow Flanger and Plow. Ill. (A small pilot snow plow attachment with "flanges" all raised and lowered by an air cylinder, designed to keep the track and flange ways clear of snow). Ry Rev-Oct. 26. 700 w.

2228. The Development of Electric Traction on Steam Lines (An editorial view of the possibility of substituting electric for steam power on our railroads. The immediate result is said to be the adoption of electric power on suburban lines, or the attempt to control such electric lines by steam power companies). Ry Rev-Oct. 26. 1300 w.

2229. The Fast Run on the Lake Shore from Chicago to Buffalo (The world's record for speed broken. A run with 3 car train, weighing 152¼ tons, from South Chicago to Buffalo, 510.1 miles, at an average speed of 63.614 miles per hour, or taking out stops, 65.073 miles per hour. Three different engines were used. Maximum speed was 92.3 miles per hour, and 33 consecutive miles were traversed at 80.4 miles per hour). Ry Rev-Oct. 26. 1500 w.

2238. The Removal of Grade Crossings in Buffalo, N. Y. Ill. (Discussion of the various proposed plans and history of the efforts to do away with grade crossings, with inset giving detail drawings of the improvements by the N. Y. C. & H. R. R. R. Specifications for this work were given in the issue of March 21). Eng News-Oct. 24. 3500 w.

2241. Management and Handling of Railway Motive Power (Abstract from the report of the Com. of the Am. Soc. of R. R. Supts. on (1) adaptation of locomotives to work they have to do; (2) economical loading of locomotives; (3) economy in fuel and supplies; (4) track and yard facilities; (5) how to obtain the maximum life service from a locomotive. It contains valuable information and suggestions). Eng News-Oct. 24. 1500 w.

2242 The Use of a Locomotive on Track Work. A. Morrison (Abstract of paper read before Am. Soc. of R. R. Supts. Specifying the various ways in which the engine of the repair train can take the place of hand labor, such as unloading rails, moving short rails on curves, moving turnouts, switches, etc., distributing ballast from the cars, etc. As an engine costs about $25 per day, it should never be idle but be utilized in every possible way). Eng News-Oct. 24. 1900 w.

2243. Specifications for the Boston Subway (Extracts from construction specifications for Section 2 of the Boston subway. Except in the case of cement specifications it embraces full details, including conduct and care of workmen). Eng News-Oct. 24. 1800 w.

2246. Track-Laying Machines for Street Railway Work. Ill. (A hoisting engine and swinging boom crane on a truck laying about 2200 ft. of track in a 10-hour day, at a cost of $5. The apparatus cost complete $1200. Illustration shows method of using). Eng News-Oct. 24. 700 w.

*2249. New Railways in Japan (Railway construction interrupted by the war, has again come to the front). Bd of Tr-Jour-Oct. 600 w.

2257. Deatto Conduit Railway System. Ill. (A new conduit system belonging to that class in which surface contacts with magnetic connecting devices are utilized). Elec Ry Gaz-Oct. 26. 500 w.

2258. The Staten Island Electric Railway. Ill. (A description of a complete, up to date suburban railway). Elec Ry Gaz-Oct. 26. 700 w.

2259. The Advance of the Electric Railway Motor. G. T. H. (Tracing the development and describing changes and improvements). Elec Ry Gaz-Oct. 26. 2300 w.

*2289. The General Railroad Situation. O. D. Ashley (The railway situation explained concisely and the remedy according to the writer's views is stated. He holds that the transportation and commercial interests of the country are identical and if one is disabled the consequences soon embarrass the other). Forum-Nov. 5000 w.

2295. Twenty-five Tons Capacity Wrecking and Construction Crane. Ill. (Supposed to be the most powerful standard gauge wrecking crane yet designed. They are made for the Boston & Albany, and the Norfolk & Western roads). Ry Mas Mech-Nov. 500 w.

2296. Tests of Single and Double Deflecting Plates (Report of a committee of the Southern and Southwestern Railway Club, giving the pyrometer and vacuum gauge readings, showing that the double draft sheet gave 13.2% more heat in the lower tubes). Ry Mas Mech-Nov. 800 w.

2301. The Trans-Siberian Railway. Ill. (Construction of the longest railway line in the world. It is a single track road costing about $165,105,250 and is built by the Russian government. The length is 4536 miles, while the Trans-Canadian line from Montreal to Vancover is but 2760 miles). Sci Am-Nov. 2. 2000 w.

2316. Baltimore and Ohio New 60-ft. Postal Car (Description, with drawings, of a new Pullman car having an inside length of 60 ft., having 6 wheels trucks). R. R. Gaz-Nov. 1. 1100 w.

2317. Statistical Diagrams of the Interstate Commerce Commission (From the 7th annual report of Henry C. Adams. A series of 5 diagrams summarizing the statistics relating to equipment, capital stock, funded debt, passenger and freight traffic). R R Gaz-Nov. 1. 300 w.

2318. The Powell-Potter Automatic Signal and Safety Stop. Ill. (An automatic track device to prevent engines over-running danger signals by automatically applying the engine air brakes). R R Gaz-Nov. 1. 1600 w.

2319. An Electric Brake for Street Railroads. Ill. (A device utilizing the retarding force of the revolving armatures and the current generated by them in magnetizing an electro magnet which presses rubbers against a revolving disc fixed to the wheel axle. With editorial). R R Gaz-Nov. 1. 1200 w.

*2321. Improvements in Permanent Way on the Prussian State Railways. R. Goering (Excerpt Minutes of Proceedings Inst. C. E. showing the advantages of double headed rails over flat bottomed rails and submitting designs for chairs, keys, etc., with an outline of proposed improvements). Ir & St Tr Jour-Oct. 19. 1200 w.

*2327. The Glasgow Central Railway (The largest underground railway in Scotland. The location, construction and operation are described and illustrated). Eng, Lond-Oct. 25. 900 w.

2339. Wheels upon Wheels (An editorial discussion of the question as to whether railways should carry bicycles for passengers free of charge, concluding that they should not do so on strictly business grounds). Ry Age-Nov. 1. 600 w.

2341. The Railways of New South Wales and Queensland (showing a marked improvement in the financial condition of these Australian roads). Trans-Oct. 25. 2800 w.

2352. Belt-Rail Checking Machine, Grand Trunk Railway. Ill. (Description of a machine for checking or gaining of the belt rails for the passage of the posts in standard box cars). Am Eng & R R Jour-Nov. 1. 800 w.

*2357. New South Wales State Railways (Editorial comment on the report of the Commissioners showing the advances made against the effect of floods and drought and valuable statistical information). Ind & Ir-Oct. 25. 700 w.

*2361. A French Side - Hopper Ballast Dumping Car (An iron car 26×8 ft. inside measure, having three dump chutes to a side, having a capacity of 15 tons of stone or gravel ballast and dumping completely). Nat Car & Loc Build-Nov. 200 w.

*2362. Larger Freight Cars (An editorial stating that the Master Car Builders' Asso. have instructed their committee to prepare plans for a 40-ton capacity freight car, discussing the tendency toward larger capacity cars and the probable effects on road and equipment). Nat Car & Loc Build-Nov. 1500 w.

*2363. Exhaust Pipe, Chicago & Northwestern Railway. Ill. (Description of a contracted exhaust nozzle made according to the recommendations of a committee of the M. C. B. Asso). Nat Car & Loc Build-Nov. 600 w.

*2364. Washing Boilers with Hot Water (Description of method used on the Norfolk and Western R. R. using supplementary boiler and pump). Nat Car & Loc Build-Nov. 800 w.

*2365. The Management and Handling of Locomotives. W. F. Potter (Read before the Amer. Soc. of R. R. Supts , claiming that a locomotive shou'd be worked up to its capacity in order to attain its greatest economy). Nat Car & Loc Build–Nov. 1400 w.

†2366. The Railway Congress on Narrow Gauge Lines (Summary of the discussion before the International Railway Congress of St. Petersburg, giving examples in actual practice). Ind Engng-Sept. 28. 1100 w.

2393. Equipment of Rolling Stock with Automatic Brakes and Couplers (Reports of the Interstate Commission on progress made on coupler and brake equipment, in compliance with the requirements of law, showing that but little has been done to alter the present equipment). Eng News–Oct. 31. 700 w.

2397. Statistics of the Railways of the United States in 1894 (A review of the 7th Annual Report of the Statistician to the Inter State Commerce Commission for the year ending June 30, 1894. Though late the statistics are valuable and interesting). Eng News–Oct. 31. 1800 w.

2398. Electricity on Steam Railroads (Abstract of address by H. G. Prout at the 25th Annual Meeting of the Amer. Soc. of R. R. Supts. The theme of his address was to lay down some of the governing principles which would determine where electricity could and where it could not be used) Elec–Nov. 6. 600 w.

2399. Storage Batteries for Railways. Maurice Barnett (The object of the paper is to emphasize the great value possessed by storage batteries—not in furnishing direct motive power, but when used in connection with railway power plants). Elec–Nov. 6. 1800 w.

2409. The Management of Railways. L. C. Fritch (Questioning whether the intellectual ability of the management has kept pace with the growth of railroading, and discussing the executive, constructive, and the managing ability of railroad men). Ry Rev–Nov. 2. Serial. 1st part. 1600 w.

2410. Grab-Irons and Draw-Bar Hights (Discussion at a meeting of the Western Railway Club upon the exact interpretation to be put upon the law requiring grab irons on all freight cars and fixing the height of draw-bars. The latter was fixed by letter ballot at from 31½ to 34½ inches above the rail). Ry Rev–Nov. 2. 1700 w.

2411. The Economy of Good Lubrication (Results of a series of tests by the Paris Lyons & Mediterranean Railway Company which led to the abandoning of grease and mineral oil as lubricants and the adoption of colza oil; also the substitution of white metal for bronze, and woolen for cotton lubricator wicks). Ry Rev–Nov. 2. 1200 w.

2423. Railroads as Manufacturers. From *Locomotive Engineering* (Discussing the manufacture by railroads of their own supplies as not being economical, and citing examples indicating that such manufacture is carried on simply as an expedient). Ir Age–Nov. 7. 900 w.

2434. Rail Making in England (A letter to the editor referring to Mr. Hunt's article on rail specifications, comparing them with similar ones in use in England and enclosing specifications made by Indian railways for English rails of flat-footed section. He believes that the English make a rail superior to those of American manufacture. Also editorial). R R Gaz–Nov. 8. 3000 w.

2435. Steam and Trolley in Connecticut. Clarence Deming (A detailed account of the struggles and competition between steam and electric passenger lines in Connecticut, with map showing location of established and projected roads Less than 75 miles of new track have been laid on the steam roads since 1875. Showing also the concentration of population along transportation lines and the probable effect of the new law compelling electric lines to own their own roadways). R R Gaz–Nov. 8. 3000 w.

2436. The B. & O. Electric Locomotive (Late pulling records showing the locomotive equal to the greatest load it will be called upon to handle. The greatest pull thus far was two coupled trains 1800 ft. long, and weighing 1900 tons giving by a dynamometer test a draw bar pull of 60,000 lbs., or an average of 40,000 lbs. at the speed of 12 miles per hour). R R Gaz–Nov. 8. 800 w.

2437. A Glimpse of the Exhaust Jet. William F. M. Goss (A paper read before the Western Railway Club on a device employed in the laboratory of Purdue University to define the form of the exhaust jet by means of anamometer tubes whose apertures can be placed anywhere in the jet of steam). R R Gaz–Nov. 8. 1500 w.

2438. The Air Brake on Freight Trains—A Chapter of Experience (This editorial shows that on the N. Y. C. & H. R. R. R. the controlling of freight trains by air brakes, has saved the company in brakemen's wages alone, over and above cost of brake repairs, maintenance, and fixed charges at least $15,000. On the Lake Shore route the average speed has been increased by 30 per cent. due to the same cause). R R Gaz–Nov. 8. 1100 w.

2439 The Best Railroad Speed Records (A compilation of some remarkable railway runs with explanation of the conditions under which they were made. The longest run, Jersey City to Oakland, a distance of 3311 miles was made at the average rate of 39.53 miles per hour. The quickest run was by the N. Y. C. & H. R. R. R., a distance of one mile at the rate of 112.50 miles per hour). R R Gaz–Nov. 8. 1300 w.

2440. Details of Interlocking Apparatus on the Michigan Central. H. D. Miles (Paper read before the Railway Signaling Club, condensed. The paper deals only with such methods as are peculiar to the Mich. Cent. Railroad, such as concrete foundations for signal connections, galvanized pipe leads to signals, etc). R R Gaz–Nov. 8. 2300 w.

2444. Losses in the Operation of Electric Railways. Herman S. Hering (Losses not usually referred to which have been investigated by the writer, such as those due to defective roadway construction, to the manner of handling the controller, to stopping and starting, and to carrying additional dead weight on the car). Elec Wld–Nov. 9. 3300 w.

SCIENTIFIC MISCELLANY

The Solar Magnetic Problem.

THE status of "the general problem of the transference of energy from the sun to the earth" is well outlined in a paper by Frank B. Bigelow (*Science*, Oct. 18). Much has been written and said upon the subject during the past 4 years. In this paper Mr. Bigelow gives a summary of present progress toward a solution of the problem, which is fundamentally important, since the sun is undoubtedly the source of all terrestrial energy.

The peculiar difficulties which have hitherto prevented definite conclusions do not arise from obscurity in the line of operations, or from mathematical intricacy, but from what Mr. Bigelow calls "looseness of the phenomena"; and he explains that by "*looseness* is meant the wide deviations from the normal laws, whatever these may be, arising from the actual spasmodic actions of the sun on the one hand, and the very indirect effect of the solar energy thus generated upon the terrestrial, magnetic, and meteorological fields, as recorded by the instruments employed in observations. This is an ordinary difficulty when the ether is the medium of the transference of energy between masses of matter widely separated in space, and in our case it is especially complex by reason of the complicated nature of the transmitter and the receiver,—namely, the sun and the earth respectively." This reduces the work of solution to "a system of approximations," while "the complication of terms is so great that it is only by the successful treatment of an enormous mass of material that the impressed force desired will emerge by the mutual destruction of other terms."

The weather bureau hopes, by increase of knowledge upon this subject, to improve its forecasts. "Meteorology has contented itself with combinations of three forces—the earth's gravitation, the earth's rotation, and equatorial insulation—acting upon the fluid atmosphere, in order to explain the observed effects in the motions of the air. The result has not satisfied students of the subject. The first point to determine was whether the sun did or did not transmit other energy to the earth, and, if it did, what kind of energy. The probability was that the auroras, the magnetic storms and earth currents, certain spasmodic actions in the electricity and magnetism of the earth's field and motions of the atmosphere, the sun spots and the coronal output, all belonged to one fundamental system, though no intelligible notion had been proposed that could explain the interrelation philosophically. The great distance of the earth from the sun seemed a barrier to one obvious explanation, so that the work was never seriously undertaken to test the validity of it."

Mr. Bigelow's own researches upon the stream-lines seen in the corona during a solar eclipse "suggested and strengthened the working hypothesis that the whole unexplained system might be referred to the sun as a magnet in dynamic operation, and that live lines of magnetic force originating in the sun were propagated to the earth in wide sweeping curves, where the energy was expended in various operations, such as those just mentioned."

He does not doubt "that a complex field of mechanical forces, besides gravitation," surrounds the earth at its surface. "In order to distinguish the field of force that was supposed to produce the aurora and the other phenomena above mentioned, it was proposed to call it 'coronal,' or 'polar' radiation, in distinction from the sunlight, or equatorial, radiation. It is radiation of some kind, if there is any transmission of energy through the ether from the sun to the earth, and it may be simply magnetic or curved radiations, as opposed to rectilinear, or electro-magnetic radiation, the latter having been practically established as natural by the work of Maxwell and Hertz."

Passing what is said upon the synodic

period (found to be 26.68 days) representing the solar field at the distance of the earth, and the classification of hitherto unworkable data to which this determination has led, we come to the following interesting summary.

"On the earth it has been shown that the permeable magnetic material is confined to a shell about 800 miles thick; that, in consequence of this, the external field divides into an exflected system, accounting for the location and movement of the auroral belt, and an inflected system, in some way related to the energy of the tropical hurricanes; that the lacking term needed to account for the spasmodic action of storm generation over our entire hemisphere is to be attributed to the solar field; that the storm tracks of the United States vary in latitude and the eastward drift of storms in longitude; that the storms are formed in the northwest in a procession corresponding to the type prevailing, and that this order is inverted with the type; that the maximum of extra-tropical storms of America, as compared with Siberia, is due to the impression of this variable energy upon the atmosphere in North America; that the prevalence of storms and cold waves in winter is due to the increased action of the magnetic field at lower temperatures; that the glacial epochs may naturally be referred to the long period variations of the sun as respects its magnetic output; that the observed minute variations of terrestrial latitudes may be plausibly ascribed to the action of the stresses in the ether at the surface of the earth, due to the mechanical forces generated in the ether by the transmission of radiant energy."

In conclusion, the desirability of magnetic observations in the northern Rocky mountains upon "the interrelation of several primary physical forces" is indicated. "The high altitude of this region, bringing the stratum in which observations are made more nearly into contact with the external field, and its proximity to the polar magnetic cap, suggest that it is the most appropriate place for the establishment of a magnificent, permanent, solar terrestrial observatory, equipped with the best instruments available, and managed by men of power in scientific investigations. One such observatory in the northwest and another in the eastern part of the United States, together with some minor stations, would no doubt amply repay the American people for the expense of equipping and maintaining them through the agency of the government."

Commercial Manufacture of Liquid Air and Oxygen.

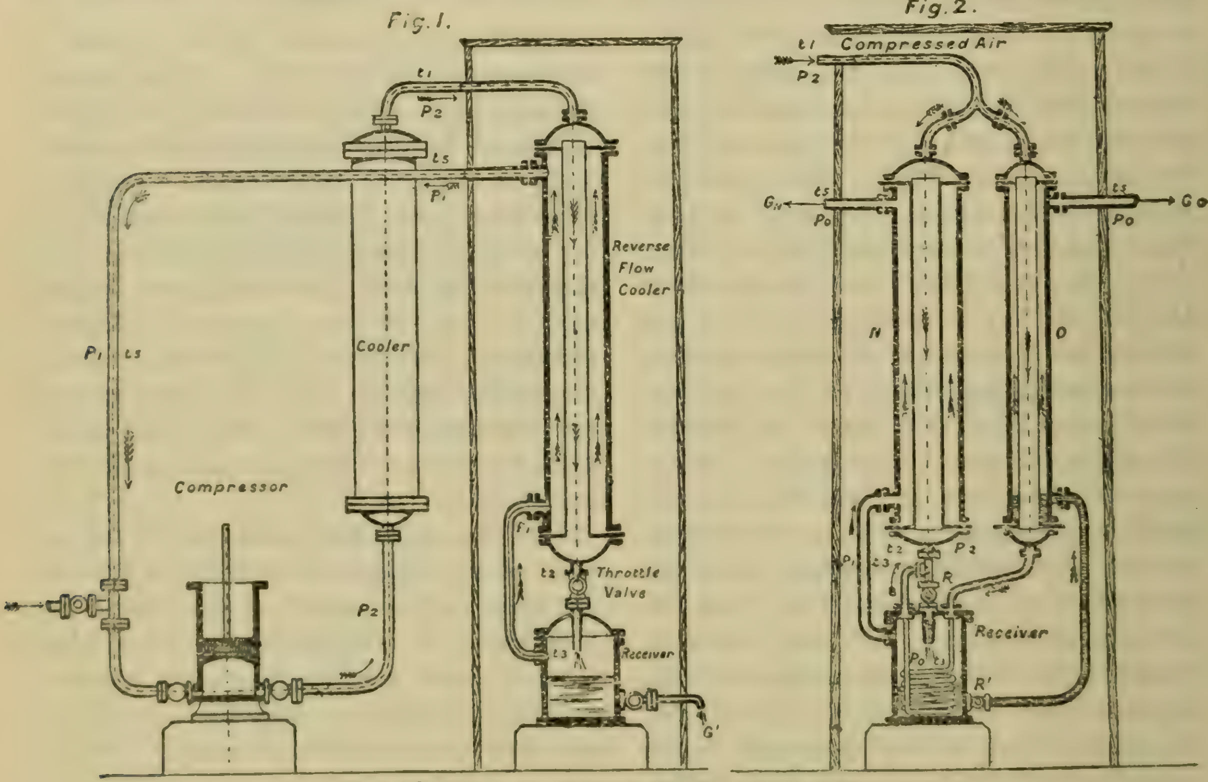
A PROCESS invented by Mr. Linde of ice-machine fame is now in the experimental stage. The successful production of liquefied air and oxygen by this process appears to be well established; the experiments are now directed to developing a commercial value for the process. The industrial applications which liquid oxygen may find in the arts are, as yet, wholly a matter of conjecture. However, it seems reasonably certain that the new process may be carried on as a commercial enterprise, should such applications create a demand for it.

The cuts show diagrammatically the nature of the apparatus employed for the purpose, and we make an abstract of the description of the apparatus and process from a paper read by Herr M. Schroter before the German Engineers at Aix, a translation of which is printed in *The Engineer* (London, Oct. 14).

"It is generally assumed that, in the case of a cold-air machine, it is essential that the compressed air shall, in expanding, do work, for otherwise,—there being no change of state, as the air is far above its critical point—the final temperature after expansion, when all parts of the system have attained equilibrium, will be equal to the initial temperature, and no cooling will be effected. This is not strictly correct, for it presupposes that air is a perfect gas, in which no intermolecular work is possible. It is true that the amount by which air departs from the behavior that may be postulated for a perfect gas—an imaginary entity—is not great, but it is perceptible, and—what is more—was measured by Joule and Thomson 40 years ago. These experimenters found that, dispensing wholly with a cylinder in which compressed air could do work, and using only an outlet in the manner practised for freezing machines using easily liquefiable gases, the air was definitely and permanently cooled.

"This cooling effect is so inconsiderable that it appears at once that a cold-air machine with merely a throttle valve, and without an expansion cylinder, would be a valuable contrivance. It is, therefore, the more remarkable that Linde, the inventor of the apparatus shown in Figs. 1 and 2, should have been able to utilize this small difference in such a way as to cause it to yield a cumulative effect great enough to permit the attainment of the critical temperature of air, and, as an immediate and necessary consequence, of temperatures still lower,—*e. g.*, —200 deg. C. = —328 deg. F., by simply handling liquid air like any other volatile liquid."

Fig. 1. Fig. 2.



LINDE'S APPARATUS FOR LIQUEFYING AIR.

Referring to Figs. 1 and 2, P_1 is the inlet, and P_2 the outlet, pipe of a compressor. The compressed air is cooled to about 14 deg. C. = 58 deg. Fah. by an ordinary water-jacket marked "cooler" in the figure. The air then passes down the "reverse flow cooler" shown on the right-hand side of Fig. 1. It will be seen that connection with the outer annular space of this cooler is entirely cut off by a diaphragm at each end. The air flows through the throttle valve and expands, doing work and becoming slightly cool. Thus, with a pressure of seventy-five atmospheres on the upper side of the valve, and one of twenty-five atmospheres on the lower, air at an initial temperature of 10 deg. C. is cooled through —12.76 deg. C., in accordance with Joule and Thomson's formulæ. The slightly cooled air flows by the side tube leading from the "receiver" —see Fig. 1—into the annular casing of the "reverse flow cooler," its course being indicated by the direction of the arrows. In thus flowing, it receives heat from the air streaming along the inner tube in the contrary direction and about to pass the throttle valve, which is correspondingly cooled. This cooled air in its turn passes the throttle valve, and is again cooled by its expansion, and serves to cool the next portion about to pass the throttle. The air flowing upwards is, at the point where it enters the annular case, at the low temperature attained a moment before by passage through the throttle, and the air on the point of passing the throttle is at the temperature which the portion next before it has reached by its own passage through the throttle. A gradation of temperature from the lower to the upper end of the "reverse flow cooler" obtains in both the inner and outer sections thereof, and at the upper end both streams of air are substantially at the same temperature,—*viz.*, that fixed by the water jacket through which the delivery pipe of the compressor passes. The return current of air passes at this temperature back to the compressor, and is there driven once more through the system, heat due to the stroke of the compressor being taken up by the water jacket, so that air at a temperature not higher than 10 deg. is constantly delivered to the upper end of the inner tube of the reverse flow cooler. In practice, this most essential portion of the apparatus—shown for simplicity as two straight concentric tubes (see Fig. 1)—consists of two spiral tubes, one within the other, 100 m. long and 10 and 4 cm. in diameter respectively. The whole is, of course, elaborately lagged, to prevent the absorption of heat from external sources. The cycle of operations, consisting of compression, expansion, and cooling, continues until the temperature of the air in the apparatus falls in the receiver to a point bebelow the critical temperature of air. A portion of the air thereupon liquefies, and a fresh quantity is accordingly introduced into the system by a second compressor,—not shown,—which serves to feed the main or circulating compressor. The process continues as before, until a sufficiency of liqud air has collected in the reeiver.

From the known relations of adibatic compression of gases, it is evident that, for attainment of economy, very high pressures must be used, and that the difference between high and low pressure must be great, while the ratio of compression remains small. A high pressure of one hundred and fifty atmospheres and a low pressure of fifty atmospheres, the ratio being one to three, satisfies these theoretical conditions. Such pressures are already successfully managed in torpedoes, and in hydrogen cylinders for balloons, and it is not anticipated that, in carrying out the new process, any greater difficulties will present themselves than have already been met and surmounted.

Birds in Flight and the Flying Machine.

To those interested in aeronautics, as inventors or constructors of flying machines, or as investigators of the attractive subject of the *modus* of flight, Mr. Hiram S. Maxim's article on the subject in the *North American Review* (Oct.) will be very interesting reading. He adopts the view that, in soaring, birds avail themselves of upwardly-flowing air currents in such manner that, though in the act of soaring they are sliding downward relatively to the body of air in which they are soaring, the upward movement of the aerial mass neutralizes the effect of this sliding relatively to the earth. He illustrates this view of the subject as follows:

"The soaring of a bird may be compared with a boy sliding down hill on a sled. If a hill is, say, 100 ft. high, and the sides slope off in a horizontal direction 2000 ft. from the summit, and if the snow is smooth, a boy can mount a sled and advance 2000 ft., while he is falling, as relates to the earth, 100 ft.; that is, the sled with the boy on it, in falling through a distance of 1 ft., develops sufficient power to drive the sled forward 20 ft.; but, when the boy is at the bottom of the hill and can develop no more power by falling, the sled soon comes to a state of rest. Suppose, now, that a hill could be made in such a manner that it would constantly rise at such a velocity that the sled would never reach the bottom of the hill, the boy would then be able to slide forever; and this is exactly what occurs with a bird. A bird places its wings in such a position that, as it falls in the air say 1 ft., it moves forward through the air 20 ft.,—that is, slides along on the surface of the air underneath its wings in the same manner that the boy slides down the hill. Suppose, now, that the velocity of the bird should be about 30 miles an hour, this would account for the whole phenomena of soaring on an upward current of only 1½ miles an hour. With an upward current of 2 miles an hour the bird would rise, as relates to the earth, ½ mile an hour, while actually falling through the air at the rate of 1½ miles an hour. There is no doubt that a bird, by some very delicate sense of feeling and touch, is able to ascertain whether it is falling or rising in the air."

It does not seem to us necessary to account for the fact that a bird knows when it is rising or falling by its sense of feeling. Sight of objects on the surface of the earth would enable it to determine this, in the same way as the relative apparent change of position of objects at different distances on a visible shore enables a boatman to determine, not only that his boat is moving, but also the direction in which it moves, and whether the motion is slow or rapid.

Mr. Maxim thinks (basing his opinion upon his own observations of air currents) that the rising columns of air are "half of the total area of the earth's surface, so that a soaring bird would always have a rising column of air which would serve as a support."

An account is given of very interesting personal observations of rising and falling air currents over the Atlantic ocean, the Mediterranean sea, and in mountainous regions. Speaking of observations of the flight of eagles in the Pyrenees, he says: "On one occasion I observed five of these birds about 500 ft. above the peak of a mountain, and they were balancing themselves in a stationary position on an ascending column of air produced by the wind blowing over the peak, and seemed to be as much at ease as if they were roosting upon a tree. With the albatross and sea-gull, it will be found that they always occupy the same position as relates to the ship. As the ship passes through the air, the air is divided exactly in the same manner as water would be, and, as it comes together again at the stern of the ship, it produces an upward current, and it is on this ascending column of air that the albatross and the seagull find a resting-place and follow the ship, for days at a time, without any apparent exertion; but, whenever they find themselves in front of the ship, or at one side, where there is no ascending column of air, they have often to work their passage very much as other birds do.

"But all birds do not soar. Ducks, geese, partridges, and pheasants are types of birds which are provided with comparatively small wings. They only remain on the wing for a short time, and, while in the air, exert an enormous amount of energy and move at a very high velocity. They do not seem to have the power to take advantage of ascending columns of air, but move in a straight line, quite independent of air currents; and it is these birds we should seek to imitate in our attempt to navigate the air."

Mr. Maxim admits that no previous theorizing upon the soaring of birds has been entirely satisfactory, and does not expressly claim that his own theorizing makes it altogether clear how birds of certain kinds can sustain themselves in the air and traverse such great distances as they are seen to do without apparent effort; but doubtless this theory is a clue which, if pursued intelligently, will lead to more accurate conceptions.

A New Smokeless Powder.

IT may not be amiss to say, as a preliminary to a review of an article on this subject in *Engineering* (Sept. 20), that smoke is not gaseous, as it is often unscientifically considered, but a cloud of solid particles suspended like dust in the air. Anything that burns completely into a gas generates no smoke. Efforts have long been made to produce powder that will not produce smoke in burning. Not only in the military art, but in mining and quarrying, is such an explosive desirable, provided that, for the latter purpose, the gases produced shall not possess materially deleterious properties. For military purposes it is also necessary that the powder should have good ballistic power, and that the chemical action of the gases upon the material of which gunbarrels are made shall not be injurious. A number of smokeless powders exist, but they do not all meet these necessary requirements.

The new smokeless powder produced in the United States by Mr. Hudson Maxim and Dr. Robert Schupphaus is that considered in the article reviewed, and both its remarkable ballistic results and its novel character and appearance are attracting public attention.

"Experience in the use of smokeless powders has developed many things not at first anticipated, and the knowledge from which have been evolved the best powders of the present time has been costly of attainment. Formerly the main object was to secure high ballistic results. The importance of the effect of the gases of combustion upon the bore of the gun was not understood, but, as powders containing very large percentages of nitro-glycerine were introduced, and many large and valuable pieces of ordnance were destroyed, the dangers arising from erosion were realized. At the present time nothing less than a stable explosive compound adaptable to guns of all sizes, which will produce as high ballistic results as possible, and will work with a minimum injury upon the gun, will satisfy artillerists.

"The Maxim-Schupphaus powder consists of about 90 per cent. pyroxylin or gun-cotton, possessing a very high degree of nitration, with about 9 per cent. of nitro-glycerine and from ½ to 1 per cent. of urea. It is a true colloid, being perfectly amorphous or structureless, and exceedingly hard and horn-like. The powder, which is made in relatively long cylinders, is perforated axially with a large number of small holes, so that a minimum of burning surface is presented to the initial flame of combustion, and a comparatively low initial pressure is secured. As, by burning, the perforations increase in diameter, the combustion surface and consequent evolvement of gases is greatly extended, so that the pressure is well maintained throughout the bore of the gun, and a maximum of propulsive energy is secured to accelerate the velocity of the projectile."

The Maxim-Schupphaus consists preferably of nine-tenths gun-cotton, the other ingredients being those of nitro-glycerine. Its high ballistic power appears to result more from the form of perforated cylinders described than from its composition. In the United States government tests of the powder at the Sandy Hook proving-grounds, some of the velcc obtained were remarkable, in contrast with the low pressures generated. A velocity of 2403 foot-seconds with a pressure of 30,600 lbs. was reached in one of the tests, thus exceeding the government requirements about as five to three. *Engineering* concludes that "the difficulties hitherto encountered in the manufacture of a smokeless powder for large guns in the form of a colloid, consisting chiefly of gun-cotton in the highest degree of nitration, known as tri-nitro-cellulose, seem to have been removed by Maxim and Schupphaus; and the high ballistic results heretofore thought obtainable only with a compound containing from 50 to 70 per cent. of nitro-glycerine have been exceeded by a compound containing only 9 per cent. of nitro-glycerine."

A New German Lamp.

THIS new lamp, according to a description of it given by Mr. Charles de Kay, consul general at Berlin, in *Consular Reports* for September, has a mantle, like the Welsbach lamp, but, instead of using ordinary illuminating gas as the agent by which the mantle is heated to incandescence, the fumes of potato spirit (chiefly amylic alcohol) are employed. It is stated that the recent rise in the price of petroleum in Germany has strongly attracted attention to this invention. Potato spirit can be very cheaply produced, but its smell is very offensive, and its fumes are highly poisonous. A lamp for using this fuel must have a safeguard against the escape of these fumes into the surrounding atmosphere. The lamp is thus described: "In order to induce the fumes to rise from the spirit into the incandescent 'hood,' a hollow metal rod with two elbows like an inverted U is arranged over the bowl of the lamp so that the two arms descend to the fluid; a wick is passed through the arms, and underneath each arm is placed a simple straight tube with a wick, which also descends to the spirit. As soon as this wick is ignited, the long arms begin to get warm above it, and the fume of the spirit begins to assemble in the bent tube and pass up through a sm hole on the upper side into the hood, where it can be ignited. To quench the light, it is only necessary to blow out the little wick below the bent tube, whereupon the latter gets cold, gas ceases to form, and the incandescent hood above ceases to operate. At present the cost of this lamp is too great to warrant a wide use of it. A complete lamp costs about $5, and the apparatus to be adjusted to a petroleum lamp costs about $3. But these prices are sure to fall rapidly, if the public takes to the invention. Another drawback is the danger of explosions.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Technical Journals—See Introductory.

*1916. Geological Research and Undiscovered Stores of Water and Coal (Extracts from the inaugural address of W. Whittaker and from addresses by J. Francis and F. W. Harmer before the Geological Section of the British Asso. Consideration of how far the sinking of wells has furnished information which will assist the geologist in the search for coal in South-Eastern England). Jour Gas Lgt-Oct. 1. 3000 w.

1928. The Vulcanizing Process of Preserving Timber (Effect of heating timber under pressure as observed in railroad ties and in bridge timbers). R R Gaz-Oct. 11. 1100 w.

1935. The Arctic Expedition of 1895, and Lieutenant Peary's work. Rollin D. Salisbury (The writer thinks that although adverse circumstances made it impossible for Lieut. Peary to carry out, in full, his plans with reference to the north coast of Greenland, he accomplished much during his Arctic residence. He cites briefly some of the scientific results). Science-Oct. 11. 1200 w.

*1961. Louis Pasteur (A brief biographical sketch and obituary). Nature-Oct. 3. 1700 w.

*1970. The Commercial Manufacture of Liquid Air and Oxygen (Discussion of a process of liquifying air and obtaining oxygen on a commercial scale, by purely mechanical means. Invented by Lind, of ice-machine fame. Illustrations of the apparatus with full description and explanation of this remarkable achievement are presented, with editorial comments). Eng, Lond -Oct. 4. 3500 w.

2006. New Flying Machine. Ill. (Inventions of Mr. Percy S. Pilcher. Light structures of wood and steel supporting a vast spread of wing and braced with piano wire). From *Black and White.* Sci Am-Oct. 19. 400 w.

2015. The Tussah Silk Industry. From *La Nature* (An interesting popular description of this industry with illustrations of apparatus and processes). Sci Am Sup-Oct. 19. 1400 w.

2016. On the Electrolysis of Gases (Experiments wherein the spectroscope was used to detect the decomposition of gases by electric discharge and the movement of ions in opposite directions along the tube. First number describes process, apparatus, and manipulations). Sci Am Sup-Oct. 19. Serial. 1st part. 2800 w.

*2043. Mr. Vernon Harcourt on Gas Production and Consumption (A lecture delivered to the students at New Cross, London. Describes materials from, and methods by which gas is made, and appliances for burning it). Jour Gas Lgt-Oct. 8. 3000 w.

*2045. Powder Making on the Pacific Coast. Ill. W. C. P. (Popular description of the mills of the California Powder Works, with illustrations of machines, processes, products, and different fire-arms for which the different kinds and grades of powder and cartridges are adapted). Overland Monthly-Oct. 3500 w.

*2046. Smokeless Powders for Shotguns. Ill. W. L. Colville (A popular account of the composition and characteristics of gunpowder, including smokeless powder, with a historical sketch of the manufacture of gunpowder in the United States). Overland Monthly-Oct. 5000 w.

2072. A Course in Astronomy for Engineering Students. George C. Comstock (Stating the author's conception of a brief course in spherical and practical astronomy as a part of the technical training of the future engineer. He considers such a course important to every engineer in whose work surveying is to occupy an important place). Science-Oct. 18. 2300 w.

2073. The Status of the Solar Magnetic Problem. Frank H Bigelow (It is proposed to summarize the evidence already obtained, and to indicate the nature of the scientific questions immediately at hand, bearing upon the transference of energy from the sun to the earth). Science-Oct. 18. 2800 w.

*2074. The Ice-Avalanche on the Gemmi Pass (Switzerland). C. S. Du Riche Preller (Descriptive of the avalanche on the Gemmi Pass in 1894 and computation of the work of the fall, result 4,400,000,000 meter-tons). Engng-Oct. 11. 1300 w.

*2107. Alkali Manufacture F. W. S. Chenhall (Chiefly historical). Chem Tr Jour-Oct. 12. Serial. 1st part. 2500 w.

2128. Simond's Electrical Pyrometer. Ill. (Description of this instrument now coming into use for hardening and tempering steel, as well as for all purposes wherein high temperatures need to be indicated). Am Mach-Oct. 17. 300 w.

2175. Helium and Argon. H. N. Stokes (Speculations based on recent observations of these substances, with account of where found and what has thus far been learned concerning them). Science-Oct. 25. 3300 w.

2176. Economics of Engineering

Works. Henry N. Ogden (Extravagance of the Americans as shown in way of living and in corporations and associations seeking their own advantage at the expense of the public good. Instances cited). Science–Oct. 25. 2800 w.

†2195. Solutions. A. W. Connor (An able discussion of what has until recently been one of the most obscure branches of physics. Recent development has thrown much new light upon the subject, which is embodied in this very valuable paper. Chemical and physical agencies and their mathematical relations to solutions of various substances by other substances are thoroughly treated). Eng Soc of School of Prac Sci–No. 8. 7000 w.

*2204. Phenomena and Research. G. Johnstone Stoney (Abstract from an article on "The Kinetic Theory of Gases, regarded as Illustrating Nature," in the *Phil Mag.* Oct. 1895. Methods of investigation with an outline of the principles). Elect'n–Oct. 18. 1600 w.

*2205. Note on the Effect of the Glow-Discharge on Oxide of Lead. E. Warburg in *Wied Ann.* (Descriptive of experiments). Elect'n–Oct. 18. 1000 w.

*2248. The India Rubber Industry in South America. From the *South American Journal* (An account of the industry and cause of the threatened famine in India-rubber). Bd of Tr Jour–Oct. 1200 w.

2303. The By-products of Slaughter Houses. Ill. (Describes the method of slaughtering animals for food, and the purposes for which inedible parts are utilized in industry). Sci Am Sup –Nov. 2. 1700 w.

23 8. The Commercial Value of Photometry. Alex. C. Humphreys (A very thorough and exhaustive paper of unusual scientific and practical value, with an appendix containing an excellent bibliology of both standard and recent literature upon the subject of photometry). Pro Age–Nov. 1. 16000 w.

†2309. An Electrolytic Process for the Manufacture of White Lead. R. P. Williams (Description of a process invented in 1892, by Arthur Benjamin Brown, chemist and mining engineer, Boston. The chemical theory as well as the practical aspects of the process are discussed). Jour Am Chem Soc–Nov. 2400 w.

†2310. The Determination of the Heating Effects of Coals. W. A. Noyes, J. R. McTaggart, and H. W. Craver (Analyses of coals from various sources in Indiana. Results obtained with Hempel's calorimeter compared with analyses and with those obtained by Berthier's test). Jour Am Chem Soc–Nov. 1800 w.

2348. The Need of a Good Engineering Library (An editorial on the Brussels Bibliographical Conference the purpose of which was 1st, the foundation of an International Institute of Bibliography, having for its object the study of all questions relating to the science of book knowledge. 2d. The adoption of a universal and international bibliographical classification). Am Eng & R R Jour–Nov. 1. 2000 w.

2349. Pilcher's Flying Machine. Ill. (Description of a machine whereby the inventor has succeeded in rising in the air, and sustaining himself for short spaces, with recent improvements. The machine is more properly a "soaring" than a flying machine). Am Eng & R R Jour–Nov. 1. 200 w.

2369. Dangers of the Sand Blowing Machine and their Removal (Describes the ill effects of the dust in working glass surfaces by the sand blast and methods whereby they may be obviated). Am Mfr & Ir W d–Nov. 1. 700 w.

†2372. On the Growth and Sustaining Power of Ice. P. Vedel (The first number contains the theory of the formation of ice on open water surfaces, rate of formation, and formulæ for computing it, and its strength at various thicknesses). Jour Fr Inst–Nov. Serial. 1st part. 3500 w.

2406.—75 cts. Calorific Determination of the Value of Fuel. George H. Barrus (Paper read before the New England Water Works Asso., Sept. 13. 1895. The purpose of the paper is to show the actual process of making these determinations and to exhibit the action of the apparatus at work. The illustrations accompanying the paper, as printed in the "Journal," replace in part the apparatus for the purpose of the exposition. Discussion). Jour New Eng Water Works Asso–Sept. 1900 w.

*2412. Wheat Smut (Nature and mode of propagation of the smut disease in wheat and other kinds of grain, and methods for its prevention). Am Miller–Nov. 1. 1000 w.

2415. Some Dry-Press Brick Plants. Ill. (An account of brick making by this process. This first part treats of the works of J. L. Burnham and Sons, and the Milwaukee Brick Co.'s yard, both in Milwaukee). Brick–Nov. Serial. 1st part. 2000 w.

2432. The Boston Public Library (Gives interior views, and illustrates and describes mechanism for distributing and delivering books, which is very ingenious and labor saving). Sci Am–Nov. 9. 2000 w.

2442. I. Louis Pasteur. H. W. Conn. II. Pasteur as Illustration of Modern Science. George Bruce Halsted (Interesting reviews of the most important scientific work of Pasteur). Science–Nov. 8. 7500 w.

†2450. Uses and Abuses of Fire and Mill Hose. W. H. Adams (Many of the abuses are unavoidable. Suggestions tending to the longevity of hose; causes of depreciation given). Ind Rub Wld–Nov. 10. 2200 w.

†2451. The Earliest Pneumatic Tires. Ill. Hawthorne Hill (Descriptive). Ind Rub Wld–Nov. 10. 1400 w.

†2452. Deterioration of India-Rubber and Its Causes. Frank W. Birchall (Causes determined by patient investigation of physical changes, determined by microscopical examination, and chemical changes studied in the laboratory). Ind Rub Wld–Nov. 10. 1200 w.

†2453. Cable-Laying in the Vicinity of New York (The building of short cables for shallow waters. Their importance and the compounds used in their manufacture. Views of boat used to lay these cables). Ind Rub Wld–Nov. 10. 1100 w.

BOOKS OF THE MONTH

Circulars further describing the books named in this catalogue may be obtained on application to the publishers.

Sprague, Rev. Franklin M. The laws of social evolution. Bost., Lee & Shepard. 1895. c. 166 pp. D. cl., $1.

Abney, W. de W. Color vision: Tyndall lectures delivered in 1894 at the Royal Institution, London. N. Y. W. Wood & Co. 1895. 241 pp. il. 8°, cl., $2.

Atkinson, Philip. Electricity for everybody; its nature and uses explained. N. Y. The Century Co. 1895. cl. 11+239 p. por. il. D. cl., $1.50.

Taylor, T. Wardlaw. The individual and the state. Bost. Ginn & Co. 1895. 90 pp. O. bds., 80c.

Krebs, Stanley L. Poverty's factory. Bost., Arena Pub. Co. 1895. cl. 2–177 pp. S. (Beacon lib. ser., v. 1, no. 4) cl., 75c.; pap., 25c.

Waring, G. E., Jr. How to drain a house: practical information for householders. 2d ed., with annotations. N. Y. D. Van Nostrand Co., 1895. cl. 6+223 pp. il.

Ashley, Ossian D. Railways and their employees. Chic. The Railway Age and Northwestern Railroader. 1895. cl. 213 p. D. buckram, $1.

Richards, Jos. W. Aluminium: its history, occurrence, properties, metallurgy, and applications, including its alloys. New ed, rev. and enl. ed. Phil. H. Carey Baird & Co. 1895. 700 pp 8°, cl., $6.

Peters, E. T. The monetary standard. Wash., D. C., The Economic Publishing Agency. 1895. c. 24 pp. O. pap., 10c.

Platt, C. Laboratory notes in qualitative analysis and medical chemistry. Phil. J. Jos. McVey. 1895. c. 2-108 pp. O. cl., $1.50.

Wright, L. A popular handbook to the microscope. N. Y. and Chic. Fleming H. Revell Co. 1895. 256 pp. il. 12°, cl., $1.

Bartlett, Edwin J. Laboratory exercises in chemistry. Bost. Leach, Shewell & Sanborn. 1895. cl. 2-113 pp D. bds., 50c.

Bonney, T. G. Charles Lyell and modern geology. N. Y. Macmillan & Co. 1895. 224 pp. por. D. cl., $1.25.

Gibbons, H. de B. The industrial history of England. 4th ed. N. Y. imported by C. Scribner's Sons. 1895. 240 pp. maps, 12°, (University extension ser.) cl., $1.20.

Connor, D. E. A treatise on electro-magnetism. Lynn. Mass. Bubier Pub. Co. 1895. cl. 73 p. il. T. bds., 50c.

Briggs, Rob. Steam-heating. New ed., rev. and enl., with additions by A. R. Wolff. N. Y., D. Van Nostrand Co. 1895. 16°, (Van Nostrand's science ser., no. 68.) bds.

Rafter, G. W. Mechanics of ventilation. New and rev. ed. N. Y. D. Van Nostrand Co. 1895. 16°, bds., 50c.

Watson, A. E. How to build a fifty-light dynamo or four horse-power motor; il. with working drawings. Lynn, Mass. Bubier Pub. Co. 1895. cl. 38 pp. sq. S.

Wright, T. W. A text-book of mechanics for colleges and technical schools. New and rev. ed. N. Y. D. Van Nostrand Co. 1895. 12°, cl., $2.50.

Smith, Richmond Mayo. Statistics and sociology. N. Y. Macmillan & Co. 1895. cl. 16+399 pp.

Tait, P. G. Dynamics. N. Y. Macmillan & Co. 1895. 12°, cl., $2.50.

Trevert, E. Electricity for students. Lynn, Mass. Bubier Pub. Co. 1895. c. 3-128 p. il. sq. S. cl., $1.

Stewart, Balfour. An elementary treatise on heat. New 6th ed. rev., with additions, by Rob. E. Baynes. N. Y. Macmillan & Co., 1895. 12°, cl., $2.25.

BOOKS RECEIVED.

Auchincloss, William S., C. E. Link and valve motions; 13th edition. New York. D. Van Nostrand Co. 1895. cl. 138 pp. 6″×9″, $2.00.

Grafton, W. McC., C. E. Railway Signaling. Madison, Wis. Published by the University. 1895. pap., 184 pp., 6″×9″.

Smith, Leonard Sewal, B. C. E. An experimental study of field methods which will insure to stadia measurements greatly increased accuracy. Madison, Wis. Published by the university. pap., 145 pp. 6″×9″.

Raymond, Maj. C. W., Corps of engineers U. S. A. Flood protection of the city of Williamsport, Pa. Williamsport, Pa. Press of The Gazette and Bulletin. pap., 72 pp. 6″×9″.

Consular reports Vol. XLIX, No. 181. Commerce, manufactures, etc. Washington Govt. Printing Office. Oct. 1895. pap., 256 pp.

Leypoldt, Augusta H., and Iles, George. List of Books for Girls and Women and their clubs. Boston Library Bureau. 1895. 161 pp. 7″×10″. cl., $1.00; pap., 50cts.

Birkinbine, John. The production of iron ores in various parts of the world. Washington, Govt. Printing Office, 1895. 204 pp. 7¾″×11¼″.

Gould, E. R. L., Ph. D. The housing of the working people. Eighth special report of the commissioner of labor. Washington, Govt. Printing Office. 1895. cl., 461 pp. 6″×9″.

WHEELER; H. A., E. M. Vitrified Paving Brick. Indianapolis, Ind. T. A. Randall & Co. 1895. pap., 84 pp. 5½″×8″. $1 00.

CAMPBELL, Frederick A., C. E. Notes and tables relative to the strength of materials. Melbourne, Australia. Published by the author. pap., 20 pp. 18d.

RULES and list of members of the Iron and Steel Institute. London. Published at the offices of the Institute. 1895. pap., 104 pp. 5¼″×8½″.

BIRKINBINE, John. The production of iron ores in various parts of the world. Washington, Govt. printing office. 1895. pap., 204 pp. 7¾″×11¼″.

MOORE, Willis L., chief of weather bureau. Monthly weather review, March, 1895. Washington, Weather Bureau, 1895. pap., 116 pp., 8″×12″, with nine infolding charts.

RAFTER, George W., C. E. Report on moveable bridges used in Europe. Albany. James B. Lyon, printer. 1895. pap., 29 pp. 6″×9″, with numerous unpaged plates.

BROUGH, Bennett H., Secretary. The Journal of the Iron and Steel Institute. London and New York. E. & F. N. Spon. 1895. cl., 571 pp. 5¼″×8¼″.

WAKEMAN, W. H. Modern examinations of steam engineers. Bridgeport, Conn. American Industrial Publishing Co. 1895. cl., 272 pp., 5¼″×7¾″.

ABBOTT, Arthur Vaughn, C. E. The electrical transmission of energy. New York. D. Van Nostrand Co. 1895. c., 586 pp,, 6″×9″.

TRANSACTIONS of the American Society of Heating and Ventilating Engineers. First annual meeting Jan. Published by the society. New York. 1895. cl., 259 pp., 6″×9″.

PARKER, Edward Wheeler. The production of coal in 1894 Washington, Govt. printing office. 1895. pap., 224 pp., 8¼″×11¼″.

MOORE, Willis L., chief of weather bureau. Monthly weather report, May, 1895. Washington. Weather Bureau. 1895. pap., 197 pp. and charts.

WARING, Geo. E. Jr., M. Inst. C. E. How to drain a house. Second edition, with annotations. New York. D. Van Nostrand Co. 1895. cl., 223 pp., 4⅝″×6⅞″. $1.25.

HOUSTON, Edwin J., Ph. D., and KENELLY: A. E., Sc. D. Alternating electric currents. New York. The W. J. Johnston Co. 1895. cl., 225 pp., 5″×6½″. $1.00.

PENCE, Prof. Wm. D., C. E. Stand-pipe accidents and failures, with illustrations and tables. New York, Engineering News Publishing Co. 1895. pap., 195 pp., 4¾″×5¾″. $1.00.

FREITAG, Joseph Kendall, B. S., C. E. Architectural Engineering. New York. John Wiley and Sons. 1895. 239 pp., 6″×9″. $2.50.

COMSTOCK, William T. The architects' directory. New York. William T. Comstock. 1895. Flexible cover. 108 pp., 5″×6¼″. $1.00.

HARROP, Herbert B. and WALLIS, Louis A. The forces of Nature. Columbus, Ohio. Harrop & Wallis. 1895. cl., 159 pp., 5¼″×7⅜″. $1.25.

BALDWIN, James, Ph. D. A guide to systematic readings in the Encyclopædia Britannica. Chicago–New York. The Werner Co. 1895. cl., 316 pp, 5¼×7¼.

WARMAN, Cy. Tales of an Engineer. New York. Charles Scribner's Sons.

RICHARDS, Frank. Mem. A. S. M. E. Compressed air, air-compression and the transmission of compressed air. New York. John Wiley and Sons. 1895. cl., 203 pp., 5″×7¼″.

U. S. DEPARTMENT of Agriculture. The world's markets. Washington. Government printing office. 1895. The German Empire. 91 pp., 6″×9″. France. pap., 74 pp., 6″×9″. Great Britain and Ireland. pap., 155 pp., 6″×9″. Canada. pap., 67 pp, 6″×9″.

ELGAR, Francis, LL. D., F. R. S. E., late director of H. M. dockyards. The cost of warships. London. Institution of Naval Architects. 1895.

AMERICAN Institute of Electrical Engineers. Transactions for 1894. Vol. XI. New York. Published by the institute. 1895. cl., 938 pp., 6″×9″, with folding chart, entitled Diseases of Dynamos.

BENJAMIN, Park, Ph. D. L.L. B. The intellectual rise in electricity. New York. D. Appleton & Co. 1895. cl., 611 pp., 6″×9″.

BOOK NOTICES.

PROCEEDINGS OF THE 28TH ANNUAL CONVENTION American Institute of Architects, held in the Fine Arts Building, New York, October 15, 16, and 17, 1894. Published by the Board of Directors, A. I. A. under direction of the committee on publication and library, Alfred Stone, editor. Providence: E. A. Johnson & Co., printers, 1895. [225 pp., 7″ × 9½″. Flexible covers].

This volume of proceedings is of more than ordinary interest.

THE TUTORIAL PHYSICS. VOLUME II. A TEXT-BOOK of Heat, with numerous diagrams and examples. By R. Wallace Stewart. D. Sc., London, first-class analyist in physics at B. Sc.; author of "An Elementary Text Book of Heat and Light," and "Elementary Text Book of Magnetism and Electricity," etc., etc. London: W. B. Clive, University Correspondence Press New York: 65 Fifth avenue. [294 pp., 4⅛″ × 6¾″.]

The same merits that have characterized the previous volumes of this series are manifested in the work under notice. The introductory matter abridging the mathematical consideration of the laws of heat is exceedingly well written. The mathematical formulæ are reduced to very simple operative forms, and the examples given are extremely well prepared with a view to the application and illustration of the formulæ. Considerable attention is paid to graphic methods, especially in that portion of the book which is devoted to thermo-dynamics. As a text book in schools this book will fill a very useful place.

NYSTROM'S POCKET BOOK OF MECHANICS AND ENGINEERING, revised, corrected, and greatly enlarged, with addition of original matter, by William Dennis Marks, Ph. B., C E. (Yale S. S. S.) 21st edition further revised and corrected by Robert Grimshaw. Philadelphia: J. B. Lippincott, 1895. [674 pp, 4″ × 6⅜″. Morocco, price $3.50.]

It is scarcely necessary to make any remarks regarding this long-known and widely-used collection of data for the use of engineers, the title being sufficiently descriptive. The work has always been regarded as authoritative, and most of the data given have been found remarkably accurate. The same care that was bestowed upon the preparation of the book in the first edition by the eminent author has been bestowed in the revision and addition of original matter.

CHEMICAL ANALYSIS OF OILS, FATS, WAXES AND OF the Commercial Products derived therefrom, from the journal of Dr. R. Benedikt, revised and enlarged by Dr. J. Lewkowitsch, F I. C., F. C. S., Technical manager of the Whitehall Soap Works, Leeds, Consulting Chemist and Chemical Engineer. London: Macmillan & Co., New York, 1895. [683 pp., 6″ × 9″. Cloth price, $7.00.]

The author tells us in his preface that, as there has not been, hitherto, a book dealing especially with the chemical analysis of oils, fats and waxes, he was on the point of writing one, when he was asked by Prof. Benedikt to render his German work, "*Die Analyse der Fette und Wachsarten*" into English, with such alterations as he thought necessary. Prof. Benedikt's book being undoubtedly the best on that subject, Dr. Lewkowitsch thought that instead of adhering to his original intention to write a book, it would be more useful to found upon Prof. Benedikt's book an English edition; he has therefore, translated, revised and enlarged the German work. Very numerous additions have been made and alterations are noticeable in nearly every page, the object being to abridge or leave out entirely obsolete processes, and to arrange the subject matter with reference to present practical requirements. Several chapters have been almost entirely re-written and a special feature is the tabular form adopted for the constants for the individual oils, fats and waxes. The work has been enlarged by devoting more space to the English and American chemists than was found in the original German publication. The descriptions of technical processes have been compressed in narrower limits, but those points which give the analysist the necessary clue to the lines to be adopted in the course of analysis have been emphasized. An apparently successful attempt has been made to amalgamate scientific accuracy with practical knowledge.

EXAMINATION OF WATER FOR SANITARY AND TECHNIQUE Purposes. By Henry Leffman, A. M., M. D., Ph. D., Professor of Chemistry in the Woman's Medical College of Pennsylvania, in the Pennsylvania College of Dental Surgery and in the Wagner Free Institute of Science; Pathological Chemist to the Jefferson Medical College Hospital; Chemist to the Dairy and Food Commissioner of Pa. Third edition, revised and enlarged, with illustrations. Philadelphia: P. Blakiston, Son & Co., 1895. [154 pp., 5″ × 7″. Cloth, price, $1.25.]

The general character of treatment has been preserved in this edition, but numerous modifications of the details of processes of sanitary analysis, as developed by various American workers, are described and discussed. The State stations for sanitary control have contributed much valuable matter to sanitary science within a few years, and this has been a source from which important additions to the original treatise have been selected.

Much of the matter has been re-written and sources of uncertainty which were pointed out in earlier editions, and, within the last few years, have become much more appreciable to the profession at large, have been treated more at length. The section on biological examinations has been considerably extended. Some of the processes for purification of water are described in detail.

EXPERIMENTS WITH A NEW POLARIZING PHOTO-Chronograph Applied to the Measurement of the Velocity of Projectiles. By Dr. Albert Cushing Crehore, Assistant Professor of Physics, Dartmouth College, and Dr. George Owen Squire, 1st Lieutenant, 3d Artillery, U. S A. Reprinted from the Journal of the U. S. Artillery. Volume IV. No. 3. Artillery School Press, Fort Monroe, Va., 1895. [Pamphlet, 42 pp., 6″ × 9″ and 22 half tone plates.]

Gives an account of a very interesting instrument and experiments with it, at the U. S. Artillery School at Fort Monroe, between the dates of the 27th of December, 1894, and the 12th of January, 1895. The diagram illustrating the results shows a probability that the record made by a break in the current by the passage of the projectile is sharp and well defined, and that it will permit of an accuracy in reading the record even beyond that attainable by measuring the intervals between screens on the proving ground.

A BRIEF REVIEW OF RAILROAD HISTORY FROM THE Earliest Period to the Year 1894. By W. Hasell Wilson, Honorary Member, Society of Civil Engineers. Philadelphia: Allen, Lane & Scott, 1895. [53 pp., 5″×7½″.]

A re-presentation of a story that has been told many times in different forms by other authors; so far as we can discover no new light has been thrown upon the subject.

STATIONARY ENGINEERS' GAZETTEER OF ILLINOIS, containing a complete list of chief engineers of all steam plants in Illinois; names of the officers; location and night of meeting of all Stationary Engineers' Associations in Illinois; also, list of supply houses, with telephone numbers and other information of interest to the craft. Chicago Stationary Engineers' Gazetteer Association, 159 La Salle Street, Room 3. [136 pp., 8″ × 10½″. Paper, price, $10.]

This appears to be a very complete and reliable directory of the Stationary Engineers of the entire State of Illinois. The work contains an accurate list of chief engineers in charge of blocks, buildings, hotels, club houses, manufacturing plants, flats, packing houses, breweries, apartment houses, etc., together with a list of engineers' supply houses and their telephone numbers. A supplement to the list of engineers contains a full and correct enumeration of the make and capacity of the engines, boilers, pumps, dynamos, electric lights, and elevators under the supervision of each engineer. A table giving the most direct route of shipment to any part of the State is appended.

BOILER ENGINEERING, BEING INTERESTING AND INstructing examples in civil, mechanical, electrical, chemical, mining, military, and naval engineering, graphically and plainly described and specially written for those about to enter the engineering profession, and the scientific amateur: with chapters on perpetual motion and engineering schools and colleges. By F. Dye, London; E. and F. N. Spon, New York; Spon and Chamberlain, 1885. [476 pp., 7″ × 9¼″. Cloth, price, $3 00.]

This book is written in popular style, and deals only with the most prominent outlines of the different subjects. It is not intended to be a thorough treatise on any of the subjects named, but to furnish to non-technical readers, and to those entering upon any of the branches of engineering named, a general idea of the nature of the work they will be called upon to perform.

AMERICAN STEAM VESSELS. BY SAMUEL WARD Stanton. New York: Smith & Stanton, 1895. [496 pp., 8″ × 12″. Handsomely bound in cloth with gilt edges, price, $5.00.]

Claimed to be the first collection of its kind ever published. A handsome volume, containing illustrations and descriptions of almost all known types of successful steam vessels that have been constructed in the United States, and also the famous and historical vessels of the early days and of our own time. The arrangement of the illustrations is chronological; the chief aim has been to secure accuracy. Illustrations of earlier steamers have been taken from wood cuts, drawings, or paintings, while illustrations of the later boats have been produced from photographs, plans, sketches, etc. There are eight hundred and seventeen illustrations in all, making a decidedly unique collection. The portraits, corners, etc., of the pages are printed in different colors, giving a very artistic effect.

ARCHITECTURE FOR GENERAL READERS. A SHORT Treatise on the Principles and Motives of Architectural Design. With a Historical Sketch. By H. Heathcote Statham, Fellow of the Institute of Architects; Editor of *The Builder*. New York: Imported by Charles Scribner's Sons. [348 pp, 8 1-2″ × 5 1-2″. Price, $3.50.]

Brief, well written, amply illustrated and dealing with topics the general reader should be acquainted with, this book fills a space no other book yet occupied, in architectural literature. The first part is devoted to a series of interesting, general essays, on the fundamental principles of architecture. The topics chosen in this part are well selected, and well treated. The author insists through out that architecture is more than the arrangement of certain materials and ideas according to rule, and that such things have little place in its history. This view is presented in a popular but philosophical manner certain to meet approval.

The second part contains a historical sketch of architecture, in which he rightly traces the evolution of the art continuously from the Egyptian to the renaissance. Through necessarily brief, the chief elements of the different styles are graphically presented, and the general reader will find here a portrayal of the leading movements in the history of architecture as a basis of further study. The book is brief, but a very wide range is covered in its well-printed pages. To many its brevity will be an added advantage. Just such a book as this has long been needed, and its author is to be congratulated for carrying out his work in so able a manner. This, indeed, was to be anticipated, his long experience as editor of *The Builder* having giving him the advantage of being able to gage the public mind in every way. Moreover, he has been enabled to see, as perhaps few have seen, the faults of existing works that profess to instruct the public and the profession of architecture. Not the least interesting fact in connection with this charming book is that its author is a practising architect. We commend the book both to architects and general readers.

HENDRICKS' ARCHITECT'S, BUILDER'S, AND CONTRACTORS' Directory of America. for builders contractors manufacturers, and dealers in all kinds of building supplies. For 1895 and 1896. New York; Samuel E. Hendricks Co. [832 pp., 6¾" × 10". Cloth, price, $5 00.]

This is claimed to be a complete directory of all the construction industries of the country, containing over 200,000 names and business classifications, comprising builders and contractors for material and construction in the building and kindred trades. It also contains full lists of the manufacturers of, and dealers in, everything employed in the manufacture of materials and apparatus used in these industries, from the raw material to the manufactured articles, and from the producer to the consumer. A complete index is provided, whereby any occupation in which the name is sought may be turned to at once. The places of residence are in capitals, which renders the research very easy. A valuable book of reference.

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

Farrel Foundry and Machine Co., Ansonia, Conn., U. S. A.=Catalogue A, 2d edition, 48 pp., 7¼" × 9¾". [Describes and illustrates the Farrel and Bacon ore- and rock-crushing machinery manufactured by the company named; also revolving screens, elevators, conveyors, road railways, &c. The company is represented by Earle C. Bacon, engineer, Havemeyer Building, 26 Cortlandt street, New York.]

Clayton Air Compressor Works, Havemeyer Building, New York, U. S. A.=Pamphlet, 86+XIV pp., 8" × 10½". [Describes and illustrates the Clayton Air Compressor; also discusses the widening use of compressed air in an article reprinted from the ENGINEERING MAGAZINE; gives complete directions for erecting and operating the Clayton Air Compressors, and suggestions for ordering duplicate parts, and describes and illustrates vertical and horizontal tubular boilers, with price list; gives in addition, as a history of success, a long list of testimonial letters.]

Lane Foundry and Machine Works, Huntingdon, Pa., U. S. A.=Catalogue, 1895, 26 pp., 4" × 7". [Describes and illustrates throttling, automatic, vertical, horizontal, hoisting, stationary, and portable engines, and vertical, horizontal, tubular, locomotive, and portable boilers.]

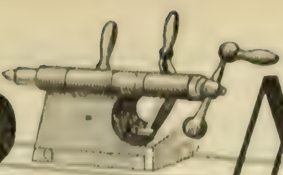
Hilles and Jones Co., Wilmington, Del., U. S. A.=Catalogue, 1895, 32 pp., 12" × 9". [Describes the line of machine tools for the equipment of iron shipyards, boiler shops, bridge works, and car and locomotive works, together with special machines for working plate and shape iron.]

The Hunt Air Brake Co., Pittsburg, Pa., U. S. A.=Instruction book for the maintenance and handling of the Hunt Air Brake system. 56 pp., 5" × 6½". [Pocket inside cover contains a plate illustrating the Hunt Air Brake system as applied to heavy, double truck electric cars, and a card illustrating the three-way valve employed in this system, with transparent revolving slip by which the operation of the valve in all positions may be easily comprehended.]

J. T. Slocomb and Co., Providence, R. I., U. S. A.=Catalogue, 16 pp., 6" × 9". [Describes and illustrates with price list a line of machinists' bench tools, including micrometer gages and calipers, combination indicators, combination center drills, and outside micrometer calipers, with directions for use; also describes a patented standard revolution counter, which registers two thousand revolutions and is constructed upon the principle of the stop-watch.]

For additional catalogues see page 600 under Improved Machinery.

IMPROVED MACHINERY

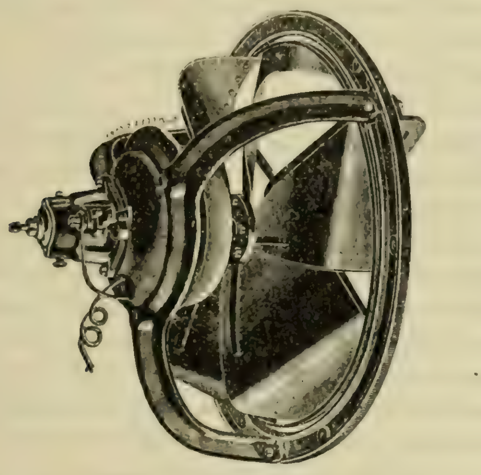


NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Lundell Exhaust Fan Outfits.

THESE combined exhaust fans and motors are made in sizes ranging from ¼ h. p. to 15 h. p. in the motors and from 18-in. diameter to 72 in. diameter of fan, the 18-in. fan running at 1000 revolutions, and the 72-in. fan running at 350. The design of the Lundell electric motor is well adapted to attachment to any of the standard makes of exhaust fans, the cost of attachment, exclusive of the price of the motor, ranging from $42 for 18-in. fans to $200 for 72-in. fans. Contrary to the usual practice of manufacturers, instead of one bearing at the front and another at the back of the fan, the shaft has two bearings in the motor frame itself, the shaft not being supported in any sense from the fan ring. With either horizontal or vertical shafts this insures perfect alignment and noiseless running. This combined fan and motor (manufactured by Interior Conduit and Insulation Co., 527 West Thirty-fourth street, New York) has other desirable features. With all their standard horizontal shaft fans, an adjustable thrust bearing—shown in the cut—is provided. When the flow of air is desired contrary to the standard direction, a button and thrust bearing is placed at the rear of the motor. Provision for oil lubrication is made for all the horizontal fans. In the vertical ones the step at bottom is lubricated with oil, and the upper end of the shaft runs in a graphite bearing. The standard motors run with currents of 115 volts, but motors are wound for 230- and 500-volt circuits.

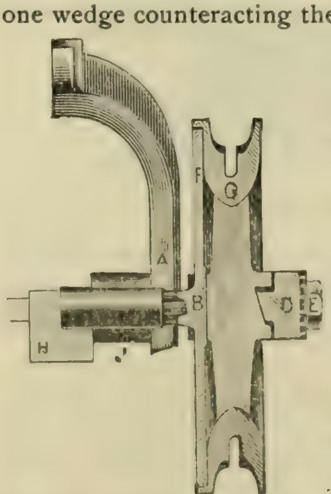


LUNDELL EXHAUST FAN.

Automatic Brake for Differential Chain Pulley Block.

THIS ingenious device which is a feature of the Moore's antifriction differential chain pulley blocks manufactured by the Moore Manufacturing Co., Milwaukee, Wis., is illustrated in the accompanying cut.

A friction plate *F* of slightly less diameter than the hand wheel is mounted upon an extension of the hub of the hand wheel and between it and the block frame *A*. The friction plate has a wedging contact with the block frame at *B*, and the hand wheel has a reverse wedging contact with the clutch *D* which is keyed to the shaft and held in position by the adjusting nut *E*. A pull on the hand chain to raise the load loosens the wedge *B* and tightens the wedge *D*, while a pull on the hand chain to lower the load tightens the wedge *B*, but loosens the wedge *D*, one wedge counteracting the other and producing no friction between the plate and the frictional surface of the wheel at the point *F*. But when the hand wheel *G* is in a state of inertia, the pull of the load on the shaft tightens the wedge *D* carrying with it the hand wheel and friction plate, tightening also the wedge *B*, and, the two wedges acting together, set the frictional surfaces into contact and effectually lock the block. A pull on the hand chain in either direction releases one of the wedges, but as soon as the pull ceases the load instantly

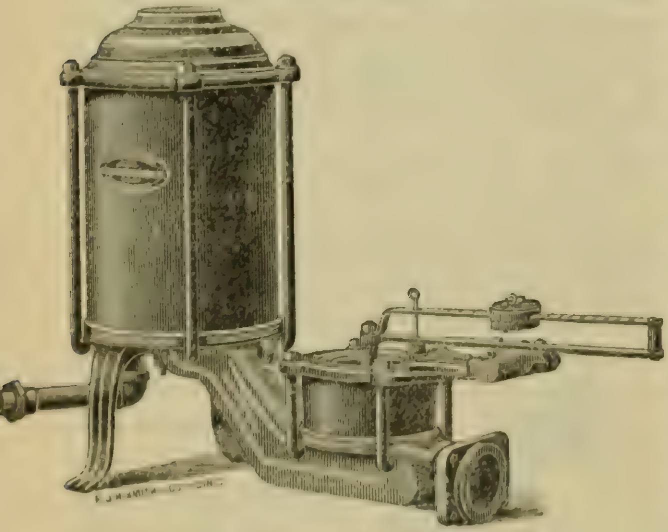


catches up and locks both of them. The lock is positive and smooth working, since the friction surfaces are really never out of contact, and heavy loads may belowered by a pull on the chain of a very few pounds.

The Rife Hydraulic Ram.

It is a remarkable fact that from 1796, the date of Montgolfier's improvement upon the hydraulic ram, up to 1887 there had not been the slightest improvement in this device, notwithstanding that thousands of them have been sold and made by the largest pump concerns in the world. These manufacturers repeatedly endeavored to build large rams, but being unable to feed air to them these machines were invariably pounded to pieces from concussion.

In 1887, an American inventor, Mr. W. A. Rife, of Waynesborough, Virginia, invented, designed, and patented the "Rife" ram, which is supplied with air automatically, by means of a peculiar construction of the base, thus enabling him to build the "Rife" ram to any required capacity and fill a long-felt demand long felt, by placing on the market a ram admittedly the only practical air-fed large ram in the world.



RIFE HYDRAULIC RAM.

These rams are used in elevating water for irrigation, and for supplying small towns, railroad tanks, colleges, etc., etc., as well as all smaller demands.

Another improvement due to Mr. Rife is that, through the use of a common check-valve, the ram becomes double acting and will deliver one kind of water while using another water as power; and, as the two waters cannot possibly mix, this improvement is of especial value. There are many springs so small or weak that they cannot furnish the power to run even the smallest ram, but, by the use of the "Rife" improved ram, muddy or branch water can be used as power to deliver pure spring water. The rams are in such cases guaranteed to deliver only the spring water.

At the World's Fair in Machinery Hall one of these rams was in constant operation, delivering seven thousand gallons per hour, as is claimed, at a cost of *less than two cents a day!* The Rife ram received the highest awards, medals, and diplomas, over all competitors at this great exposition. The Power Specialty Co., 126 Liberty street, New York, are supplying these excellent machines and may be addressed for further particulars.

Translucent Fabric.

This new material is steel wire cloth covered with a semi-transparent, impervious material. It is evident, upon inspection of a sample, that it will be found adapted to many uses. It is, strong, durable, non-inflammable, a non-conductor of heat, light, and cheap. It is adapted to use in sky-lights, roofs, windows, train-sheds, green-houses, hot-houses, translucent partitions, office doors, and other uses. The material in which the reinforcing web of wire cloth is embedded is a peculiar chemical substance claimed to be as durable as any known elastic substance. Neither heat or cold, rain, snow, hail, or sleet affect it. Hot coals, cinders, etc., falling upon it will not ignite it. It is weather-proof, perfectly flexible, and as translucent as skylight glass. Its non-conducting quality helps to keep a building warm in winter and cool in summer. Its weight is only from $\frac{1}{7}$ to $\frac{1}{10}$ that of glass, depending upon the thickness of the fabric. We are informed by the manufacturers, Translucent Fabric Co., 64 Federal street, Boston, Mass., that this new material is meeting with unqualified appreciation among architects, builders, and engineers, and that many representative firms are using it in preference to glass for purposes to which it is adapted. The skylight roof of the monitor running the entire length of the new forge shop of the Berlin Iron Bridge Co., at East Berlin, Conn., is of this material, and the president of that company, Mr. Charles M. Jarvis, testifies strongly to its merits.

The greatest record of the year in the output of the Homestead, Pa., Steel Works, was made in October, when every department of the immense plant, without a single exception, made the largest output in any one month of the history of the plant. In beams and channels the output was 19,600 tons and the 119-inch plate mill turned out 8537 tons.

Heating and Ventilation in the High School, Arlington, Mass.

THE heating and ventilating plant placed in the above-named school by Messrs. Smith, Anthony & Co., of Boston, Mass. (being the system of apparatus manufactured by the Huyett and Smith Manufacturing Co. of Detroit, Mich.), having been examined and inspected by Mr. Joseph A. Moore, Massachusetts State inspector of public buildings, the inspector reported to the chief of Massachusetts district police, the chief in turn transmitting the report to the chairman of the building committee of the school.

"RUFUS R. WADE, ESQ.,
"Chief Inspector and Chief of Massachusetts District Police:

"SIR,—In accordance with your instructiors given at the request of the chairman of the new Arlington high school building committee, I have, in company with Inspector John T. White, made a careful inspection of the ventilation of said building.

"In the eight school rooms there are possible accommodations for 352 scholars. The supply of air in these rooms averaged 48.8 cubic feet per minute for each of the 352 scholars. The amount of air exhausted by the vent-ducts averaged 52 cubic feet per minute for each scholar that could be accommodated. The number of pupils at present in the building is very much smaller than the number of seats. The amount of air supplied in the hall in the third story was 5473 cubic feet per minute, taken with the air ducts open into all the other rooms. With the ducts to the other rooms partly closed, the supply was 10,654 cubic feet per minute.

"Two tests of the purity of the air in the master's room, with forty pupils present, made at quarter past twelve o'clock, gave 4.9 and 5 parts of carbonic acid in 10,000 parts of air. The outside air containing 4 parts of carbonic acid in 10,000 of air, it will be seen that the inside air was nearly as pure as that outside. The hallways and corridors were all warm, and the air was first-class. The sanitary closets were in first-class condition, well ventilated, and no disagreeable odors could be found.

"The amount of fresh air supplied and foul air exhausted was fully up to all the requirements of first-class ventilation. The temperature in different parts of the several rooms was very even, and the circulation of the air was first-class.

"I consider this one of the very best ventilated school buildings in the State."

At the same time the following report of Mr. Thomas Hawley, State inspector of boilers, was transmitted to the chairman of the building committee by Chief Wade:

"RUFUS R. WADE, ESQ.,
Chief District Police, Boston, Mass.:

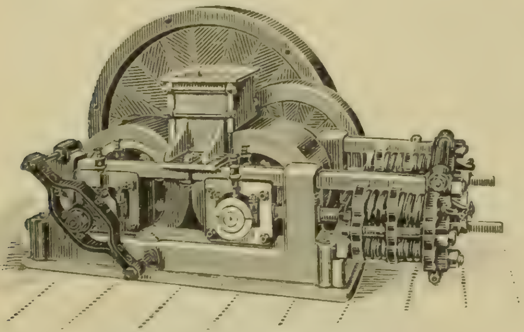
"DEAR, SIR—I have inspected the boilers and heating apparatus at the Arlington high school, and report as follows: The two boilers are known as the "Star water tube," and each consists of an internal fire box with water tubes crossing the furnace. From an external inspection, the boilers appear in good condition, and, as constructed, are efficiently braced, and provided with all the fittings necessary to safety, and well arranged. The boilers are amply large enough to heat and ventilate the building in zero weather, and the steam plant as a whole is a safe and excellent one, and well set up."

Such reports as these must be extremely flattering, both to the manufacturers of the apparatus and to the contractors who placed it in the building.

Improved Ore Crushing Rolls.

THE Colorado Iron Works of Denver, Colorado, have introduced important improvements in rolls for ore crushing, commonly known as "Cornish Rolls." Rolled steel tires only are used, and are claimed to be the best in use. The frames are made in one solid massive casting, making the machine rigid and self-contained, thus insuring permanent alignment of the various working parts. The universal boxes of these rolls, as designed and applied by Mr. Franz Cazin, are pivoted in guide frames in such manner as to always conform to the shafts, however much one side of the rolls may be fed more than the other. A bar or other heavy piece of iron or steel may pass by accident between the rolls near one end, thus spreading the rolls apart at that end an inch or two, and still throw no excessive strain on the box or the shaft, as the box is pivoted on trunnions in the sliding box frame, and remains in line with the shaft.

A very complete device, also of Mr. Cazin's designing, keeps the end adjustment of the rolls exact, which is a most important feature not heretofore provided for. It is the universal experience that after rolls have run awhile, one or other of them begins to wear endwise against one of the boxes, and soon they are not exactly opposite, that is, they overlap each other at the ends, which trouble grows worse every day as they wear down, leaving a high ridge or flange on opposite ends of the two rolls, and when this happens nothing can be done to stop the trouble but to send them to the shop to be turned down parallel again. With the device adopted it takes but a moment to bring the two rolls opposite each other when they begin to wear away, and the evil is corrected at once.



IMPROVED ORE CRUSHING ROLLS.

Heavy wrought-iron guide bars are applied both above and below, and the universal box frames are carried and guided by these bars, which also extend through the corner posts of the main frames, and at one end carry the springs on the two sides of the machine.

The springs are carried in frames or cages on the two sides of the machine at one end, each side entirely independent of the other, and these springs are put in place under a pressure of eight to eighteen tons, depending on size of machine, on each side. This arrangement of the springs is a most important one, in that the rolls are held in relative positions under 16 to 36 tons pressure, and there is no movement apart or away from each other in ordinary work. Only when some pieces of iron or steel, as a bar, or gad, or pick point, passes through, this pressure is exceeded, and the springs yield and let the obstruction through, and the rolls at once reassume their proper relative position automatically. Thus there are less fines, and less coarse lumps than pass through rolls of ordinary construction, and the jiggling and consequent wear of the boxes in the guides is entirely avoided.

The rolls are housed in completely, which obviates the wasteful and disagreeable nuisance of dust. Where housings are not required, as in sampling mills, the hoppers are bolted by suitable clamps and flanges to the top guide bars, by which bolts and nuts are made easy of access, and the hopper can be removed entirely in a minute. The best material and workmanship are employed in these machines.

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

Naylor Bros., Peekskill, N. Y., U. S. A.=Catalogue, 64 pp., 4½" × 7". [Describes and illustrates a line of pulleys, hangers, shafting, and power-transmitting machinery, with price list.]

Jenkins Bros., New York, U. S. A.=Catalogue, 68 pp., 7½" × 5". [Describes and illustrates a full line of globes, angle and cross valve, wood wheel radiator valves, gate valves of the well known "Jenkins" trade mark, made with iron or steam-metal bodies, and also the Jenkins standard packing with price list, etc.]

The Rife Hydraulic Engine Manufacturing Co., Roanoake, Va., U. S. A., and Pacific Department, San Francisco, Cal., U. S. A.=Pamphlet, 35 pp., 3½" × 5⅜". [Describing and illustrating the Rife Automatic Hydraulic Engine or ram for irrigation, water supply of small towns, railroad tanks, factories, steam mills, dairies, country residences, stock yards, etc.]

Irvin Van Wie, Syracuse, N. Y., U. S. A.=Catalogue, 48 pp., 6¾"×10". [Describing centrifugal and triplex pumps manufactured at the Baldwinsville Centrifugal Pump Works, of which Mr. Van Wie is the proprietor.]

. Davis-Farrar Co., Engineers, Erie, Pa., U. S. A.=Catalogue, 24 pp., 9"×6". [Describing and illustrating centrifugal pump machinery, single, compound, and triple-expansion marine and stationary engines and boilers.]

Follansbee Bros. Co., Pittsburgh, Pa., U. S. A.=Memorandum book, 3"×6". [Blank, except covers, which contain the advertisement of the sheet iron, roofing iron, tin and terne plates, tools, and machines manufactured by this company.]

The Columbian University, Washington, D. C., U. S. A.=Catalogue for academic year, 1895, 199 pp., 5"×7½".

William Cox, Civil Engineer, Stapleton, N. Y., U. S. A.=Leaflet, 4 pp., 6"×9". [Describes and illustrates a mechanical device designed to solve, by means of Kutter's well-known, but complicated formula, problems relating to the flow of water in pipes, and, to a considerable extent, in open channels.]

Stover Manufacturing Co., Freeport, Ill., U. S. A.=Pamphlet, 64 pp., 6"×9". "Irrigation." [Describes and illustrates the "Ideal" wind-mill with list of sizes, capacities, and prices.]

†1740. Notes on Water Gas. George Ritchie (Paper presented to the West of Scotland Iron & Steel Inst. A description of two continental gas plants, at Essen and Berlin, used for metallurgical purposes, and for heating and lighting at Hamburg). Ind & East Eng–Aug. 31. 1800 w.

For additional catalogues see page 596 under Books of the Month.

THE

ENGINEERING MAGAZINE

VOL. X. JANUARY, 1896. NO. 4.

REPRESENTATIVE MONEY AND GOLD EXPORTATIONS.

By Horace White.[*]

REPRESENTATIVE money is anything promising to pay money, which circulates as a common medium of exchange. It is usually made of paper, but sometimes of a cheap metal. When it is issued by a government, and is legal tender, it is called fiat money.

Money, as we have seen, is an instrument of exchange. There may be too many or too few of these instruments at any time or place, as there may be too many or too few carts or wheelbarrows. When the money is a commodity of general use in the world, like the precious metals, then, if any country has more than it needs, there will be an exportation of the surplus ; if less, there will be an importation. This movement is automatic. It is as certain to take place as an exportation of grain when there is a surplus, or an importation when there is a shortage. Nobody, not even the government, can prevent it.

Now let us see what happens when the government forces its own notes into circulation. Suppose that one million dollars was just enough before, and that the government adds one hundred thousand. If the conditions of trade and industry remain the same, there will now be one hundred thousand too many instruments of exchange, and the surplus will be exported. Since foreigners will not take the paper, the exported instruments will be the metallic ones.

Suppose that the government issues one hundred thousand dollars more. The surplus cannot be exported, because foreigners will not

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[*] This is the second of the two articles designed to indicate, by selected quotations, the outline of Mr. Horace White's argument in his admirable book entitled "Money and Banking." The preceding article, entitled "First Principles and the Gold Standard,"

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take it. The goods and property in circulation were formerly measured by one million dollars. They are now measured by twelve hundred thousand. Prices will rise. This means that the currency is now depreciated. It will probably be depreciated rather more than the quantity would indicate, because people will expect further issues and will anticipate them by charging more for their goods. Those who are receiving fixed incomes, whether wages, salaries, or interest, will be cheated, because the things they buy will cost more, while their receipts will be no greater. Uncertainty will be introduced into business. The investment of capital will, for this reason, be retarded, while speculation will be promoted.

The first government paper money in this country was issued by the colony of Massachusetts in 1690, in order to pay soldiers who had returned without their expected booty from an expedition against Canada. The general court issued £40,000 in due bills, which were made receivable for taxes and exchangeable for any commodities in the treasury. In 1692 the bills were made legal tender in all payments, and receivable for taxes at five per cent. better than silver and redeemable in silver at the end of twelve months. These provisions made them equal to silver.

It was a fatal experiment. Its apparent success as a means of postponing taxes led to disorders far worse than the commodity currency of the earlier period. No kings, however tyrannical, ever debased the money in circulation so recklessly, persistently, outrageously, as the colonial assemblies.

Contemporary history tells us that these sins were not committed through ignorance. It was not through ignorance that Massachusetts, for example, watered her currency till one pound sterling would buy eleven pounds of paper money, and then repudiated all but one-fifth of it.

Thomas Paine tells us how the speculators and debtors were then working for bills of credit. He says:

> There are a set of men who go about making purchases upon credit, and buying estates that they have not wherewithal to pay for; and, having done this, their next step is to fill the newspapers with paragraphs of the scarcity of money and the necessity of a paper emission, then to have legal tender under the pretence of sup-

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appeared in our December number, and it should certainly be read by everyone who reads this one.

We have before referred to the rare excellence of this book. The simple truth is that, in a compact and most entertaining little volume, it gives the whole history of money and banking in the United States, from the earliest settlement of the American continent to date; and, using the familiar events of our financial history as illustrations of the principles of monetary science, it makes the whole subject so perfectly clear that every reader can comprehend. In view of the present and pressing importance of the money question in the United States, it is a book which every man of intelligence and influence should read. Published by Ginn & Co., Boston; price, $2.

> porting its credit, and, when out, to depreciate it as fast as they can, get a deal of it for a little price, and cheat their creditors; and this is the concise history of paper-money schemes.

Bad as the colonial fiat money was, that of the revolutionary period was worse. Even Franklin, who had been a pronounced greenbacker in earlier times, now recoiled. The issues ran on, in an increasing volume, till they amounted to $245,000,000 in the year 1779. In 1781 the whole mass became worthless. The essays of Pelatiah Webster on this subject have become classics. Mr. Webster was a merchant of Philadelphia and an ardent patriot. He wrote while the paper-money experiment was going on. We can readily believe him when he says:

> We have suffered more from this than from every other cause of calamity; it has killed more men, perverted and corrupted the choicest interests of our country more, and done more injustice, than even the arms and artifice of our enemies.

Continental money was now an object of execration and afterwards of derision. "Not worth a continental" became a synonym for absolute worthlessness.

One of the striking phenomena of the Revolution was the great display of luxury. Franklin wrote in 1779: "The extravagant luxury of our country in the midst of its distresses is to me amazing." Another writer says: "Every form of wastefulness and extravagance prevailed in town and country, nowhere more than in Philadelphia under the very eyes of congress,—luxury of dress, luxury of equipage, luxury of the table."

This is not hard to understand. If a man owed $1,000 gold value and was enabled to pay it with $100, he had $900 disposable for other purposes. As this money had not come to hand by hard knocks, he would naturally be somewhat free in spending it. He would give good dinners, drive fast horses, and buy fine clothes and jewelry for his family. It was the transfer of property from frugal persons to spendthrifts. Like conditions prevailed during the civil war, both north and south.

At the beginning of the civil war the amount of gold in the country was unusually large. If it had been left in the banks, it would have served the same purpose during the war as before. Business transactions are no greater in amount in war than in peace, although somewhat different in kind. No more gold would have been needed, if it had been used for its proper purpose of bank clearings,—*i. e.*, as a touchstone of the paper currency. The banks ought to have made it a condition of their loan ($150,000,000 on August 9, 1861) that Mr. Chase should draw checks for his disbursements to be settled at the clearing house in the usual way. They were the masters of the situation. If they had insisted, he would have had no option but to yield. Upon this point Mr. George S. Coe, one of the most prominent men in the negotiation, says:

> The banks would have conferred an incalculable benefit upon the country, had they adhered inflexibly to their own opinions. But the pressure of startling events required prompt decision, and the well-known intelligence and patriotism of the secretary gave to his judgment overwhelming power.

Mr. Chase insisted upon carrying away the gold and scattering it through the country by means of the sub-treasuries and distributing offices. The amount so scattered was $170,000,000, and it cost a good deal to cart it around. The result was that the banks suspended specie payments on the 28th of December, 1861.

The committee of ways and means, on the 7th of January, 1862, by a majority of one vote, agreed to report a legal-tender bill proposed by Elbridge G. Spaulding of Buffalo. This action produced a great commotion in the world of finance.

A delegation of bankers from New York, Boston, and Philadelphia came to Washington to remonstrate against it. A meeting was held at the office of the secretary of the treasury on the 11th of January, at which these gentlemen and the members of the financial committees of the house and senate were present. Mr. Gallatin, in behalf of the bankers, presented a plan of national finance which would, in the opinion of those gentlemen, procure the means for carrying on the war without recourse to legal-tender notes. One of the proposals was to "issue six per cent. twenty-year bonds, to be negotiated by the secretary of the treasury, and without any limitation as to the price he may obtain for them in the market."

Mr. Spaulding took ground at once against this plan. He tells us that he "objected to any and every form of 'shinning' by government through Wall or State street to begin with; objected to the knocking down of government stocks to seventy-five or sixty cents on the dollar, —the inevitable result of throwing a new and large loan on the market, *without limitation as to price.*"

In order to avoid selling government stocks at seventy-five or sixty cents on the dollar in an honest way, Mr. Spaulding initiated a policy which ended in selling those stocks at forty cents on the dollar in a roundabout way, and cheating creditors, soldiers, and laboring men out of more than half their dues in an incidental way. This state of facts he mournfully acknowledges in his book, and he seeks to put the blame on Mr. Chase for too much inflation of the currency. But the man who opens the floodgates has no right to complain of the inundation.

The bill became a law on the 25th of February, 1862. It provided for the issue of $150,000,000 of notes. On the 7th of June Mr. Chase asked for $150,000,000 more notes. A bill for this purpose was passed with very little opposition.

The third batch of legal-tender notes, $100,000,000, was authorized by a joint resolution dated January 13, 1863, "for the immediate payment of the army and navy of the United States." The whole amount now authorized was $400,000,000. The price of gold at this time was 142; at the end of the month it was 159. Mr. Spaulding was surprised, at this juncture, to find that there was a great scarcity of currency. This he attributed, not to the advance in prices, which had absorbed the additions to the circulating medium, but to the operations of the army and navy. He did not explain how the operations of a million men fighting and destroying property should call for more currency than the same number engaged in peaceful occupations at home.

An important change was made by the act of March 3, 1863, in the character of the old legal-tender notes. By the terms of their issue they were convertible into six per cent. gold-interest bonds at par, and these words were printed on the back of each note. Mr. Chase desired that this privilege should be taken away, so that he might reduce the rate of interest on future bond issues. Congress reluctantly yielded to his request, fixing a period a few months distant (July 1, 1863), when the right of conversion should cease. This was an inexcusable breach of contract, and a shocking blunder to boot, for it had the effect of preventing the early resumption of specie payments. Whenever the six per cent. bonds were above par, the notes would be converted into them and retired. This operation, being perfectly natural, being part of a contract, and coinciding with a popular feeling at the close of the war favorable to specie resumption, would have certainly worked out that result within a brief period. This feeling was expressed by a vote of 144 to 6 in the house, on the 18th of December, 1865, in favor of contraction of the currency with a view to early resumption.

Secretary McCullough in 1865 recommended that the greenbacks be gradually retired by cancelling a certain proportion of those received for taxes, and congress passed a law authorizing such retirement at the rate of $4,000,000 per month. This was done until the amount was reduced to $356,000,000, when congress repealed the law.

The money circulating among the people is a powerful educator. It teaches either truth or falsehood. Sometimes the results of its false teachings are merely whimsical; more often they are disastrous. Our legal-tender act taught people to believe lies. First, it taught them that the government's bonds were payable in greenbacks. The policy of paying the 5-20 bonds in greenbacks was made a political issue by General Butler in the Republican camp, and by George H. Pendleton in the Democratic, immediately after the close of the war. They and many other politicians advanced the fantastic conceit that the government could pay the first piece of paper with a second one. If it could do so, then, as Professor Newcomb said, it could pay the second piece with the first. So, by a game of see-saw or thimble-rigging, the whole debt could be paid without taxation. As all the other governments could rightfully do what we could, all national debts might be settled in a twinkling. But there would be no need of taking the trouble to exchange an interest-bearing bond for a non-interest-bearing note. The whole debt could be cancelled by simply passing a law saying: "All bonds of the United States are legal tender and shall cease to bear interest after the passage of this act." If that could be called *paying* the debt, what would be repudiating it?

The reader who has penetrated thus far into the labyrinth of our currency legislation will need a clue in order to get back to daylight. It is easily supplied. The various kinds of money in circulation, exclusive of subsidiary coins, fall into two classes, namely:

MONEY.	REPRESENTATIVE MONEY.		AMOUNT.
Gold.	Fiat money	1 Greenbacks	$346,681,016
		2 Treasury notes	152,584,417
		3 Silver dollars	57,029,743
		4 Silver certificates	337,148,504
		Total fiat money	893,443,680
		5 National Bank Notes	206,854,787

All the things in the right-hand column are issued by the government, and are fiat money, except the national bank notes. It is customary to say that the various things composed of, or based on, silver (numbered 2, 3, and 4) are real money to some extent, because of the metallic value of the silver dollar. This is true only in case the government is at liberty to sell the silver. There is no law authorizing the secretary of the treasury to do this. Strike out from the list of representative money numbers 2, 3, and 4, and write greenbacks in place thereof, and assume that the government has certain assets of uncertain value composed of white metal, some of it stamped and some unstamped, then you know everything that can be known about the multifarious currency issued by the government of the United States. Silver dollars are metallic greenbacks. They are at par with gold because they are limited in amount and because the government receives them as the equivalent of gold at the custom house and the tax-office.

The money of the country consists of all the gold, plus all the other instruments of exchange that are redeemable in it. It follows —and has been proved by abundant examples—that a scarcity will be cured after some delay by an importation of gold, and a plethora will be equally corrected by an exportation of it.

It is the proper business of banks to supply a deficiency and to redeem and retire an excess of the circulating medium, as the case may be. There is a general understanding of this truth, and it finds expression in the common saying that "the government ought to go out of the banking business." Banking implies the receiving of money on deposit from certain persons and the lending of it to other persons for hire. This is common to all banks, but some banks add another function,—that of issuing and redeeming circulating notes, which take the place of metallic money in the community. The former of these functions may be, and often is, exercised without the latter, but the latter ought never to be exercised without the former, because there is no means of testing the needs of the community for instruments of exchange except by holding them at the service of the bank's depositors. There is no other way for bank notes to get out of the bank, except as they are taken out by persons who have the right to draw checks on it. These are the depositors. Each depositor knows exactly how many bank notes he needs. He will draw out no more or no less, and, when he has on hand any more than he needs, he will deposit the excess in the bank. As all depositors do the same, the needs of business are answered automatically. As the government has no such machinery, it has no means of squaring the volume of the currency to the needs of business. It has no means of knowing what the needs of business are, and, if it had any, it would still be without means of responding to them, except by taking a vote in congress. After taking the vote, it would still be without any method of placing the money where it was really needed.

The redemption of fiat money is always liable to contingencies. The government may not be *able* at all times to redeem it. The government may not be *willing* at all times to redeem it, in which case it cannot be coerced, or fined, as a bank may be for similar default. The national honor is a very poor substitute for the sheriff and his posse, to keep specie payments going, because so many people have to be consulted, and because different views prevail as to what the national honor requires. We have had some recent illustrations of this divergence of ideas between different branches of the government on such a delicate question. Such differences tend to create panics and cause runs on the treasury.

There is a vast amount of floating capital in the modern world which seeks investment on call, or short time. It may be at New

York to-day, at London a month hence, at Paris, Berlin, Vienna, Amsterdam, or other places, at short intervals, or divided among all of them. It is capable of being transmuted into gold and sent hither and thither at short notice. A very slight inducement will cause it to be turned this way or that way. It is always on the alert to make a profit or to avoid a loss, especially the latter. It was this sort of capital that was taking wings and leaving our shores, accompanied by a considerable amount of American capital in the same liquid state, last winter.

The greatest objection of all to fiat money is that it teaches people to believe lies. It creates the belief that the government can make money,—that is, real, not representative, money,—than which a more damaging lie never gained lodgment in the human brain. It has kept political parties in hot water for thirty years. It is an obstacle to the nation's progress, and ought to be put out of its misery without further delay.

The striking concurrence of opinion between Mr. White, writing as an economist and thinker, and President Cleveland, writing as the chief executive of the American people, charged with putting theory into practice, is shown by the following recommendations contained in the president's message to congress last month:

> I am convinced the only thorough and practicable remedy for our troubles is found in the retirement and cancellation of our United States notes, commonly called greenbacks, and the outstanding treasury notes issued by the government in payment of silver purchases under the act of 1890.
>
> The currency withdrawn by the retirement of the United States notes and treasury notes, amounting to probably less than $486,000,000, might be supplied by such gold as would be used on their retirement or by an increase in the circulation of our national banks. Though the aggregate capital of those now in existence amounts to more than $664,000,000, their outstanding circulation based on bond security amounts to only about $190,000,000. They are authorized to issue notes amounting to 90 per cent. of the bonds deposited to secure their circulation, but in no event beyond the amount of their capital stock, and they are obliged to pay 1 per cent. tax on the circulation they issue.
>
> I think they should be allowed to issue circulation equal to the par value of the bonds they deposit to secure it, and that the tax on their circulation should be reduced to one-fourth of 1 per cent., which would undoubtedly meet all the expenses the government incurs on their account. In addition, they should be allowed to substitute or deposit, in lieu of the bonds now required as security for their circulation, those which would be issued for the purpose of retiring the United States notes and treasury notes.
>
> The banks already existing, if they desired to avail themselves of the provisions of law thus modified, could issue circulation in addition to that already outstanding, amounting to $478,000,000, which would nearly or quite equal the currency proposed to be canceled. At any rate, I should confidently expect to see the existing national banks or others to be organized avail themselves of the proposed encouragements to issue circulation, and promptly fill any vacuum and supply every currency need.

CRIPPLE CREEK GOLD MINES AND THE STOCK BOOM.

By T. A. Rickard.

THE vicissitudes of mining are proverbial. The fascinating romance of western development offers many a page telling of the ups and downs of settlements whose oddly-chosen names are now a part of the record of American enterprise. Cripple Creek, the mining camp whose recent achievements have made it a subject of interest to the commercial world, has had a career as chequered and brilliant as any of those whose names have been words to conjure with in the mining excitements of the past. The Comstock, Tombstone, Leadville, the Cœur d'Alene, Wood River, the Black Hills,—what pictures of potentialities of wealth beyond the dreams of avarice do they not recall! Picturesque discovery, rapid development, extraordinary productiveness, insane speculation, honest endeavor, ill-gotten gain, exhaustion, collapse, succeeded after an interval of convalescence by another cycle of similar events. It is an old story, whose brighter aspects are treasured as a part of the heritage of the children of the departing pioneer, the unpleasant features of which are buried in that forgetfulness which is happily characteristic of an optimistic humanity.

The wave of emigration which, after the financial panic of 1857, swept westward until it broke against the ramparts of the Rocky mountains was the vanguard of a new civilization. To those who were carried forward by its impetus there ever loomed above the sea of the prairies the beacon whose white crest on far horizon gave promise of the land of gold. That beckoning guide was the snowclad peak which Capt. Zebulon Pike had reconnoitred forty years before. The "Pike's peak or bust" motto of the pioneer sounds but mock heroic in our ears, and yet it expressed something of the mingled humor and daring which were no small part of the equipment of the men who first pierced the unknown wilderness of what was then the western portion of the territory of Kansas.

Although the peak thus lent its name to the mining excitement of that time, no gold discoveries of any moment were made in the streams or on the hills that lay at its feet. The rugged ranges which look up at Mt. Arapahoe, Gray's peak, and Mt. Evans were the scene of the beginnings of Colorado mining. Time has of late reversed his wheel and justified the expectations of the tenderfoot of forty years ago by the uncovering, upon the southern slopes of the old beacon mountain, of a gold-mining region of a richness and extent far exceeding those of any of the districts first opened up by Gregory or the Russells in the days before 1860.

Cripple Creek, the latest born and the goodliest of Colorado's galaxy of mining camps, lies under the very shadow of Pike's peak. Though the first recorded locations bear date of February, 1891, the district was previously well known on account of having been the scene, seven years earlier, of the notorious Mt. Pisgah fiasco.

Among the clustering hills which, like a flock of sheep, spread southward from the granite battlements of Pike's peak there is a dark cone somewhat detached from its smaller brethren. It is Mt. Pisgah. And just as Moses from the top of the Asiatic Pisgah looked over a land flowing with milk and honey, so the modern prospector, saturated with an ill-assorted medley of fact and fancy, ascends this Colorado hill, and from its summit sees a country which, to him, at some vaguely remote period, flowed with porphyry and gold. But Mt. Pisgah has an unsavory reputation. In April, 1884, three or four thousand men stampeded thither on the rumor of a great discovery. No gold was found in workable quantity, except in the prospect holes of the first locators. Salting was suspected, and an accomplice was caught with a bottle of yellow stuff in his pocket. It was not whisky, but its latter-day antidote, chlorid of gold. Lynching was threatened, but in the failure to lay hands on the real perpetrators of the fraud the affair broke up in a big picnic and a general drunk. What digging had been accomplished was unsuccessful, though one or two veins were found that carried from $3 to $4 in gold per ton. It makes one cynical to think how near those excited and deluded prospectors were to the eve of a big discovery. No mines have to this day been found on the slopes of Mt. Pisgah, but the town of Cripple Creek is within a rifle shot, and on the opposite grassclad slopes there are scores of engines throbbing loudly as they hoist the produce of several series of successful mines. And one can almost fancy that Mt. Pisgah's dark front grows gloomier as it contemplates the "might have been."

It is not known to many that even earlier than the episode just chronicled there was silver mining at Cripple Creek. In the days before the labor troubles in the late unpleasantness of 1893 such a fact would have been more attractive than it is to-day when the white metal is discredited and we are all possessed with the *sacra fames auri*. However, as far back as 1874 there was a hole sunk on what is now the well-known Elkton vein, and out of it there came ore which carried 30 ounces of silver per ton. In the neighboring mine, the Moose, also locally celebrated for its productiveness, I have seen specimens of horn silver (cerargyrite or chlorid of silver). The same specimens showed native gold. A recent shipment of 30 tons gave a return of 74 ounces silver and 50 ounces gold per ton.

Nevertheless, it was not until the close of 1893 that Cripple Creek came to the front. Two years before that the name had begun to be mentioned in mining circles, but the contemporaneous discoveries of large silver lodes at Creede diverted attention for the time. The collapse of the silver market in June, 1893, prostrated Creede, in company with all the other silver-producing camps, and caused the concentration of the energies of the State upon its gold resources. At this period the men of Aspen and Leadville flocked into a camp which theretofore had been left to the less experienced hands of the pleasure-loving community of Colorado Springs. Cripple Creek's development progressed apace, and resulted in the immediate opening up of several rich mines and the commencement of a steadily growing gold production.

Cripple Creek is the *fin de siècle* mining camp. Before it was two years old, it had two railroads uniting it with the highways of commerce. When scarce emerged from the tent stage of its growth, it was illuminated by electricity. To day it possesses several stock exchanges, and it has already passed through the measles of a real estate boom.

Some one has said that, like Rome, Cripple Creek has its seven hills. It is indeed true that the productive part of the district covers about twenty square miles spread over a group of low hills whose grass-clad slopes, occasionally darkened by a cluster of pines, remind one of the fact that only a short time ago this was a region valued as a cattle range. The smooth contours have since been broken by innumerable prospect holes, whose waste dumps of yellow rock seen at a distance suggest the irruption of the surface by an army of gophers. On nearer approach the variety of the rocks exposed in these surface workings becomes evident even to an untechnical observer, and, on referring to the recently-published report of the United States geological survey, one recognizes immediately that the petrography of the region is so complex and varied as to give the colored map the appearance of a crazy quilt.

Of the geology of the district much might be said, did space permit. When first investigated by the men who came from the older settlements of Colorado it proved so puzzling as to give the impression that it was unlike any other mining region in the State. Experience with the fissure veins of Clear Creek and Gilpin counties or with the limestone deposits of Aspen and Leadville seemed at a discount, and caused many absurd misconceptions regarding the vein structure of the new district. Then there somehow arose the impression that professional geologists and properly-trained mining engineers did in its early stages condemn the camp on account of its unfamiliar formation. This is distinctly untrue. It was the so-called "practical miner"[*] who from the pages of a local experience generalized concerning a district having appearances unfamiliar to his restricted vision. The fact is that the structural geology of Cripple Creek is such that it at once impresses the trained observer as possessing all the environment required for the deposition of valuable ores. It is not the least pleasing of the recollections of the writer that in 1893, standing inside certain surface excavations on Battle mountain, he stated the conviction that he was looking at the beginnings of a big mine. Those surface workings have since then developed into the celebrated Independence mine, easily the most interesting scientifically and most valuable commercially of the gold producers of the camp.

No district within modern observation so well illustrates the more recent views on ore deposition to which much attention has been directed by the writings of the late Prof. Posepny and others of his school. The region is a complex of volcanic rocks, penetrating and, in part, covering, the basal granite. The ore occurs largely in the form of a later enrichment of dikes which traverse the older eruptives. A striking structural feature, of great practical importance in the exploration of the mines, is that sheeting of the rock by reason of which it becomes divided by numerous parallel fracture planes, some of which are accompanied by ore. The deposition of valuable mineral aggregates on one or more of such lines of fracture and the passage of the ore-streak from one to the other cause complications which will enable the young science of geology to guide its older blind brother, the industry of mining.

In parenthesis I would call attention to a very striking geological parallel existing between Cripple Creek and the Thames district in New Zealand. It may be well also to remind Colorado men that the masses of andesite breccia characteristic of their new gold field also occur in far more enormous bodies in the San Juan region, and that this formation is there marked by inclosing veins having a mineralization by no means dissimilar in many respects to that noted at Cripple Creek.

Boulder county (Colorado) and Transylvania, the ancient Dacia, in Europe, offer further examples of an association of tellurid minerals to be compared with similar mineralogical occurrences in this district.

The ores of Cripple Creek are of considerable variety and remarkable beauty. Crystalline native gold is common in all the rich discoveries. It is associated with those compounds of gold, silver, and tellurium which are technically termed tellurids. The characteristic mineral is called calaverite by the gentlemen of the United States geological survey, although Dr. Pearce and others familiar with the ores consider that the analyses indicate that it is sylvanite.* It is a silver-white mineral, often in elongated crystals and associated with dull red splashes of native gold, whose graphic habit indicates that it was derived from the decomposition of the tellurid. The most striking mineral association of the region is that of native gold and purple fluorspar. The coloring imparted by the presence of the latter produces contrasting tints of remarkable beauty.

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[*] As if a miner could be other than practical. The unnecessary emphasis on the latter word is usually by way of apology for general ignorance.

To the metallurgist who is called upon to extract the values in these ores the most evident feature of the material shipped to him for treatment is its identity with country rock. That the ores of veins are frequently composed of rock in place impregnated by mineralizing waters is a theory susceptible of proof in many localities. At Cripple Creek it is an immediately obvious fact. The managers of the Denver smelters will tell you of their astonishment in receiving, in the early days of the camp's history, carloads of material which to them seemed to be rock excavated from a railroad cutting, which by mistake must have been switched into the place of ore-cars. Much of the ore is phonolite, andesite breccia and granite, so little changed that it needs no second glance to recognize the rock type, while it does require careful scrutiny to distinguish the evidences of mineralization.

Of the persistence of the ore in depth there is already excellent evidence ; but in this matter, as in other impressions concerning the gold field, it is very necessary to emphasize the statement that, owing to the variation in the rock structure, there is a notable diversity in the character of the veins uncovered in different parts of the region. Generalizations are proverbially dangerous ; they become particularly so in reference to the behavior of ore deposits distributed amid radically different geological environments. Thus I am persuaded that the ore discoveries in certain parts of the Cripple Creek area are doomed to be of a comparatively restricted nature. The experience of some of the mines already corroborates this view. On the other hand, certain systems of vein fissuring, notably on Battle mountain, bear the impress of being destined to remarkable continuity and persistent productiveness. No vein within my knowledge has shown itself so unaffected in richness by a change in the country rock or so superior to the impoverishing changes which usually accompany increasing depth as the Independence, which penetrates from porphyry (an andesite breccia) into granite without any evident diminution in values and cuts right across the contact between the two formations with no disturbance in its continuity save a local widening of the ore body. The ideal "true fissure vein" of the geologists of the old school of Henwood and Von Cotta is here amply fulfilled.

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* Calaverite carries tellurium 55.5, gold 44.5, with variable, but very small, percentage of silver. Sylvanite carries tellurium 55.8, gold 28.5, silver 15.7 per cent.

The ores of Cripple Creek are distinctly high-grade. The chief Australian mining centers* produce millstuff whose average contents are 9 dwts. per ton, the typical mines of California† do very well with quartz even poorer than that, the older districts‡ of Colorado are happy with 6 to 8 dwts. per ton, and the mines of the Rand, which made South Africa the leading gold-producing country of the world, are doing great things with conglomerates averaging 11 dwts. per ton. Cripple Creek's output carries an average of nearly 3 ounces of gold per ton. The 40,000 tons received during the past year by one smelter alone averaged $78 per ton, or over 3½ ounces. The first-class ore of many of the mines carries more than 10 ounces of gold per ton. It is not remarkable, therefore, that a comparatively small tonnage should run up into big figures. The yield for 1895 is sure to reach eight million dollars. At the close of the year the monthly production is quite double that of the beginning, and there is promise of a continued increase.

Thus, therefore, there is ample scientific evidence and commercial proof of the value and resourcefulness of the new gold field, fully warranting the inauguration of mining enterprises of great moment.

Side by side with healthy development and honest effort there has sprung up a mushroom growth of stock exchanges whose function it is to offer a vent to that hungering for sudden wealth which is the curse of our day. Just now the newspapers give more space to the transactions in stocks than they do to the actual operations at the mines, and the multiplication of exchanges has progressed so far that the camp itself has three, Colorado Springs has organized four, while Pueblo and Denver are hastily following suit. Every day sees the registration at the office of the secretary of State of a dozen or more mining companies having a nominal capital of a million dollars or more and an unproved mining claim for its sphere of operation. The subdivision of liability by the creation of a great number of low-priced shares has proceeded so far that $50 can buy several thousand shares. These low prices are used as a bait to catch small fish. Persons unable to take an interest in a properly-equipped mining enterprise are seduced into a traffic which enables them by the payment of their small savings, to profit by the rise, sure, so it is said, to follow the boom. The philosophy of such transactions is usually simple. A speculator may be foolish to buy a thousand shares in the Great Wild Cat Extended Mining and Milling Company for the sum of $10 or $20, but there is the glorious probability, verging on a certainty, that another more foolish speculator will appear, upon whom these shares can be subsequently unloaded at a nice profit. This little human frailty is the basis for the widespread promotion of numberless companies and the issue of a flood of prettily-engraved stock certificates.

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*Bendigo and Ballarat.

†In Calaveras, Amador, and Nevada counties.

‡Clear Creek and Gilpin counties.

This result is fed on statements of the greatest inaccuracy published in the press and voiced by men who have been hitherto considered well informed. The owner of a well-known mine has stated that any patented, though undeveloped, claim within the Cripple Creek mineral area is worth $25,000 ; and such a statement is at once utilized by those promoters whose business it is to sell that which they do not possess to those who do not want it. A conservative and distinguished smelter manager pronounces the opinion that only the high-grade ores are at present being treated, that there is an unlimited supply of low-grade ores in the mines of the district, and that the multiplication of reduction plants will render this supply available and enormously augment the returns. This is a delusion. The veins of Cripple Creek are characteristically small, and equally as characteristically carry ore of very high grade ; the amount of low-grade ores remaining in the mines is strictly limited, and neither requires any very extensive addition to the leaching establishments now in operation,* or warrants the instituting of parallels with the output of South Africa. The output for 1895 will be about 150,000 tons, averaging about 3 ounces per ton. The *monthly* production of the Rand is over 300,000 tons containing about ⅔ ounce of bullion, or a trifle over ½ ounce of pure gold, per ton. Comparisons of a misleading kind are, nevertheless, daily made by writers in the daily press who have no proper knowledge of the Cripple Creek mines and possess scarce a bowing acquaintance with the first facts pertaining to the industry of the Witwatersrand.

The immediate fruit of all this is a rapid growth in stock speculation which is calculated to injure rather than aid legitimate mining. Cannot we profit by the experience of the past, and take to heart the old saying, *qui va piano, va sano?* The worst of all waste is the waste of experience. Let those who desire to invest in mines (and no form of investment is more alluring or, under proper restrictions, more profitable) base their expectations on what is in the mine rather than on the uncertain vagaries of a speculative epidemic ; let them work ore and not the public, and, eschewing two-cent shares in million-dollar companies organized on the slim foundation of a ten-foot hole, wait their opportunity to invest in mines properly developed and thoroughly examined by competent and reputable engineers. It is a truism, so stale as to be cynical, to say that the world's oldest industry requires the use of methods common to our every-day business. Mining, to be successful, requires the aid of the best modern skill. The chances for disappointment are sufficient without creating new ones by a willful disregard of the necessary care and playing the fool, as many do, with the expectation that miracles will happen.

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* The writer does not lose sight of the fact that just now the output is ahead of the reduction plants, but it will not require any remarkable additions to the plants to overcome this.

Just as the phenomena of ore occurrence in the Cripple Creek region invite for their decipherment the aid of geological observation, so also the exploitation of the mines and the treatment of the ores require the assistance of the kindred sciences. It is too late in the day, it is too much of a puerile disregard of the experience of our elders, for us to embark in large mining enterprises without an equipment of business judgment, technical skill, care, and economy.

In considering the rapid development of our new gold field attention is attracted to a wider phenomenon. The collapse of silver, two years ago, has proved in many ways a blessing in disguise. It checked that discounting of the future which is at once the charm and the bane of our western life ; it put a stop to a mania for reckless extravagance, and ushered in an era of sound economy ; it awakened the resourcefulness and demonstrated the latent pluck of the citizens of Colorado ; and it has resulted in throwing fresh life into the development of our gold resources, as is now evidenced by the opening up of new centers of production, not only at Cripple Creek, but also in the Leadville district, in the San Juan, in old Gilpin, and in other regions whose records are a part of the story of American achievement.

THE FUTURE OF THE AMERICAN IRON TRADE.

By James M. Swank.

THE editor of THE ENGINEERING MAGAZINE asks me to send him for publication my views upon the above far-reaching subject. To do this in a way that will afford instruction to his readers I must be both prophet and statistician. In the latter capacity I feel sure of my ground, but in the former I am admonished that it is possible to go very far astray. There is, however, one rule to be observed in peering into the future which commends itself to all prophets, and which, in its application to our iron and steel industries, may be said to blend prophecy with statistics. It is contained in Patrick Henry's declaration, "I know of no way of judging the future but by the past."

First, then, we will look at the past of these great American industries. This past covers a longer period of time than is generally supposed. Beginning with an abortive attempt at ironmaking on Falling Creek, Virginia, in 1622, and with a successful attempt at Lynn, Massachusetts, in 1645, the manufacture of iron was fully established before the Revolution in all the original thirteen colonies, except Georgia. Historic names are associated with our colonial iron industry. Mordecai Lincoln, of Scituate, Massachusetts, from whom Abraham Lincoln was directly descended, was the principal owner as early as 1703, in company with his brother, Daniel Lincoln, of the Bound Brook Iron Works, not far from Hingham. Augustine Washington, the father of George Washington, was engaged in the manufacture of pig iron at Accokeek Furnace, in Stafford county, Virginia, at the time George Washington was born, in 1732, and he retained his connection with this furnace and with other iron enterprises of the Principio Company, of Maryland, until his death in 1743. His iron interests were continued in the Washington family down to the Revolution. Several signers of the Declaration were colonial iron manufacturers, as were also two of the most notable officers of the Continental army, General Nathaniel Greene and Colonel Ethan Allen. In 1742 Benjamin Franklin invented the Franklin stove, which is still in use in some old Pennsylvania houses. Pig iron and bar iron were exported from the colonies to England in the first half of the eighteenth century, and shipments of these articles to the mother country attained considerable proportions in subsequent years down to the breaking out of hostilities.

After the Revolution our iron and steel industries were further developed, but slowly and spasmodically for many years, owing to the severity of foreign competition, which was only occasionally checked by tariff legislation. With the enactment of the Morrill protective tariff on March 2, 1861, and with the added stimulus of the civil war, our iron and steel industries at once entered upon a period of extraordinary development, which, with some interruptions, has continued to the present time, greatly surpassing the development of like industries in any other country.

Our blast-furnace practice has been completely revolutionized since 1860 by the introduction of more powerful blowing engines and improved hot-blast stoves, by the increased height and width of the furnaces, and by the general use of bituminous coke and of richer and purer iron ores, the latter coming chiefly from the Lake Superior region. In 1865 not more than 100,000 tons of coke were consumed in the production of pig iron in this country, but now many times as much pig iron is produced with coke as with all other fuels combined, the consumption of coke in our blast furnaces amounting this year to more than 7,000,000 tons. In 1860 only 114,401 tons of iron ore were shipped from the Lake Superior mines, but in 1890 there were shipped 9,012,379 tons, and in 1895 the shipments promise to amount to 10,000,000 tons. As a result of all these changes, we have recently made in one year more than ten times as much pig iron as we made in any year immediately prior to 1861, and with a smaller number of furnaces in active operation. In 1860 we made 821,223 tons of pig iron, and in 1890 we made 9,202,703 tons.

The total production of steel in the United States in the census year 1860 was reported to have been 11,838 tons, part of which was blister steel and the remainder crucible steel, both products of very old manufacturing processes. We had just commenced the manufacture of crucible steel. In 1864 the manufacture of bessemer steel in this country was successfully undertaken, and in 1868 we made our first open-hearth steel. In 1892 our production of all kinds of steel, chiefly bessemer and open-hearth steel, was 4,927,581 tons.

In the rolling and forging and founding of iron and steel, in the manufacture of heavy as well as light machinery of iron and steel, and in the adoption of labor-saving appliances in the mining and shipment of iron ore and for the handling as well as the production of iron and steel, this country has always kept pace with the world's progress, and in many particulars it has shown the superiority of its methods over those of all other countries.

It is only just to say that the marvelous progress of our iron and steel industries since 1860 could not have been possible if we had not in the meantime opened one after another the rich iron-ore mines of the Lake Superior region, and gradually, year after year, substituted Connellsville coke for other fuel in the blast furnace. Other ores, notably the cheap ores of some of the southern States, and other coke, notably that of the Pocahontas Flat Top region, have in recent years contributed largely to our production of iron and steel, but it is nevertheless true that without Lake Superior ores and Connellsville coke we would still be in vassalage to Europe for many iron and steel products.

It was not until 1867 that we began to substitute bessemer-steel rails of domestic manufacture for iron rails, although small lots of bessemer-steel rails were imported in 1864, 1865, and 1866. In 1872 we made 808,866 tons of iron rails, which was the largest yearly product ever attained, and only 83,991 tons of bessemer-steel rails. We continued to make more iron rails than steel rails until 1877, but in that year iron rails fell behind steel rails, and ten years later, in 1887, we made 2,119,049 tons of steel rails, practically all of which were bessemer rails, and only 20,591 tons of iron rails. In 1894 we made 4,674 tons of iron rails. Our iron-rail industry, which attained its maximum growth in 1872, is now virtually extinct. So completely have steel rails taken the place of iron rails in this country that in 1894, according to *Poor's Manual*, 84.8 per cent. of the total railroad track of the United States had been laid with steel rails. This change has chiefly taken place within the last fifteen years. In 1880, according to the me authority, iron rails still formed 70.9 per cent.as of our total railroad track.

Ten years ago the making of heavy armor plates was an untried industry in this country, but to-day our heavy armor plates are admitted to be the best in the world, and within the last year the Russian government has purchased American armor plates in preference to those made in European establishments. The rapid strides which this country has made in the last few years in the building of steel merchant vessels for ocean and lake service and in the building and armament of a new navy are the world's wonder, and reflect the highest credit upon our steel manufacturers as well as upon our shipbuilders. The great progress that has been made in late years in this country in the construction of steel bridges and in the substitution of iron and steel for wood in the erection of public and private buildings, particularly the very high buildings that are now to be seen in all our large cities, could not have taken place, if our iron and steel manufacturers had not first demonstrated their ability to produce the structural forms required and at low prices. It is within the bounds of probability that the production of structural steel in this country in

1895, embracing beams, beam girders, zee bars, tees, channels, angles, and plate girders, will amount to 1,000,000 tons. Excluding plate girders our production of structural steel in 1894—a year of depression—amounted to 505,901 tons.

It was not until near the end of the first quarter of the present century that we made any considerable quantity of nails with the cut-nail machines with which the present generation is familiar. Until 1883 all our cut nails were made of iron, but in that year we began to make them of bessemer steel, and in the same year steel-wire nails began to come into use as a substitute for cut nails. In 1894 nearly all our cut nails were made of steel, but the quantity of cut nails produced had fallen far below that of wire nails, the production for that year being as follows: cut nails, 2,425,060 kegs; wire nails, 5,681,801 kegs.

It may be doubted whether many persons realize the magnitude of the steel-wire industry of this country. The 5,681,801 kegs of wire nails manufactured in 1894 were the equivalent of 253,652 tons. Almost as many tons of steel wire for fencing are also annually produced. The manufacture of wire rope is another leading branch of our steel-wire industry, and so also has been the manufacture of telegraph and telephone wire. Electric railways, too, require large quantities of steel wire. As has been shown, we did not make the steel for these articles until after 1860. The wire cables for the Brooklyn bridge, which was completed in 1883, were made of American steel.

Closely related to our steel-wire industry is our wire-rod industry. Twenty years ago we made very few steel-wire rods. The duty on rods was increased in 1883. In 1888 we made 279,769 tons of iron- and steel wire-rods, and in 1894 we made 673,402 tons, virtually all of which in both years were made of steel.

Our tinplate industry, the youngest of the industries belonging to the American iron trade, is wholly the creation of the last five years. Its marvelous growth is shown in the following summary from official statistics of our production of tinplates and terne plates during the four fiscal years beginning with July 1, 1891, and ending with June 30, 1895: fiscal year 1892, 6,092 tons; fiscal year 1893, 44,562 tons; fiscal year 1894, 62,153 tons; fiscal year 1895, 86,518 tons. This progress was made during a period which embraced two years of severe financial depression, followed by a sharp reduction in the tinplate duty. While we have been so rapidly developing our tinplate industry, we have developed with equal rapidity the manufacture of black plates, or sheets, to be tin-coated or terne-coated.

Natural gas has played an important part in the manufacture of finished forms of iron and steel since 1874, when it was first used in this country in puddling and heating furnaces and in the generation of steam. In 1886 every rolling mill and steel works in Allegheny county, Pennsylvania,—55 in all,—used natural gas as fuel, and in the same year it was used in 13 other mills and steel works; in most of them it was used exclusively. In 1887 there were 96 mills and steel works which used natural gas as fuel, either wholly or in part, and in 1889 there were 104; but at the beginning of 1894, owing to the exhaustion of many sources of supply, there were only 79. The number has since declined. It is worthy of note, however, that the development of our iron and steel industries has been greatly promoted by the use of this model fuel, and that our tinplate industry especially owes much of its original and present activity to the use of natural gas in Indiana and some other States.

The rapid development of our iron and steel industries since 1860 could not, of course, have been possible without the aid of skilled metallurgists and engineers, who have in turn been largely indebted to our scientific and technical schools; yet it is remarkable that it was not until after the opening of the thirty-five-year period under consideration that the chemical analysis of iron ores, blast-furnace fuel, and pig iron received general attention. As late as 1866 few furnacemen ever thought of having iron ores, fuel, limestone, slag, or pig iron analyzed. Now practically all iron ores and pig iron in this country are sold by analysis, or upon reputation established by analysis, and chemical as well as physical tests are required in all sales of finished iron and steel which are subjected to extraordinary strain or pressure.

One result of the improvements that have taken place in the manufacture of iron and steel in this country in the last thirty-five years has been the partial or complete abandonment of time-honored methods of production which could not compete with the new methods. In 1860 only iron was used in the production of bars, rods, plates, sheets, and rails, and the puddling furnace was an indispensable agency in their production. To-day the puddling furnace is second in importance to the bessemer converter and the open-hearth furnace, which will encroach upon it more and more from year to year. The Danks puddler, from which so much was expected twenty years ago, is never mentioned. The cementation furnace for making steel and the slitting mill for making nail rods survive only as curiosities. The blast furnaces that were run by water have nearly all gone. Except for special purposes, the day of small furnaces is over. Forges for making bar iron from pig iron disappeared about 1860, but forges for making blooms, billets, and bars direct from the ore and blooms from scrap iron and pig iron have made a more vigorous struggle for existence; yet nearly all of these have also disappeared. As late as 1850 there were more pig- and scrap-iron forges in Pennsylvania than rolling mills, and as late as 1876 there were more iron-ore forges in New York than rolling mills. For many years after 1860 there were more iron-ore forges than rolling mills in several southern States.

The low prices at which steel rails of home manufacture have been sold to our railroad companies will serve as an illustration of the cheapening of all iron and steel products in this country. The average price of bessemer-steel rails at American mills in 1870 was $106.75 a ton, in currency. The duty of $28 a ton was imposed in that year, and the price of steel rails fell in five years to an average of $68.75 a ton, and it has never since risen above these figures, but has steadily fallen in most of the succeeding years. In the whole of the year 1894 the price was $24 a ton, and in the early part of 1895 it was $22 a ton, or less than a cent a pound. It is now $28 a ton, which is exactly the amount of the duty that was imposed in 1870.

During the whole of the thirty-five years under review the extension of our railroad system has been the leading commercial factor in building up our iron and steel industries. Our railroads have called for large quantities of iron and steel for rails, bridges, cars, locomotives, and other purposes. At the close of 1860 there were in this country 30,626 miles of steam railroad completed and in operation, and at the end of 1894 there were 179,279 miles, these being Mr. Poor's figures. With the exception of 64.74 miles of elevated railroad in New York and Brooklyn, the mileage of elevated and street railways is not included in the above figures for 1894. *The Street Railway Journal* for July last gives the aggregate track mileage of these railways, including elevated roads, as 13,588 miles.

I have entered sufficiently into details to show the marvelous progress of our iron and steel industries since 1860, and also to illustrate the substitution of new for old methods of manufacture and of steel for iron. I will now present a table which will show the yearly growth of some leading branches of our iron and steel industries from 1860 to 1894, and also the yearly production of pig iron by Great Britain during the same period of thirty-five years.

The statistics of pig-iron production by Great Britain are given to show how much more rapid has been the progress of our pig-iron industry since 1860 than that of our rival. Great Britain produced almost as much pig iron in 1860 (3,826,752 tons) as the United States produced in 1880 (3,835,191 tons); and yet, notwithstanding the fact that we started so far behind in the race, we made in 1890 more pig iron than Great Britain had made in any previous year or has since made. Her maximum production (8,586,680 tons) was attained in 1882; ours (9,202,703 tons) in 1890.

Our production of bessemer-steel rails exceeded that of Great Britain in 1879, and we have ever since retained the leadership in this branch of the steel industry. Beginning with 1884, we have continuously led our great rival in the production of bessemer-steel ingots, and since 1890 we have been uniformly in advance of Great Britain in the aggregate production of all kinds of steel.

Years.	Total Shipments of Lake Superior Iron Ore. Gross tons.	Production of Pig Iron in the United States. Gross tons.	Production of all kinds of Steel in the United States. Gross tons.	Production of Iron and Steel Rails in the United States. Gross tons.	Production of Pig Iron in Great Britain. Gross tons.
1860......	114,401	821,223	11,838	183,070	3,826,752
1861......	49,909	653,164	....	169,480	3,712,390
1862......	124,169	703,270	....	190,993	3,943,469
1863......	203,055	846,075	8,075	246,221	4,510,040
1864......	243,127	1,014,282	9,258	299,437	4,767,951
1865......	236,208	831,770	13,627	318,118	4,825,254
1866......	278,796	1,205,663	16,940	384,623	4,523,897
1867......	473,567	1,305,023	19,643	412,596	4,761,023
1868......	491,449	1,431,250	26,786	452,423	4,970,206
1869......	617,444	1,711,287	31,250	529,988	5,445,757
1870......	830,940	1,665,179	68,750	553,571	5,963,515
1871......	779,607	1,706,793	73,214	692,619	6,627,179
1872......	900,901	2,548,713	142,954	892,857	6,741,929
1873......	1,162,458	2,560,963	198,796	794,712	6,566,451
1874......	919,557	2,401,262	215,727	651,262	5,991,408
1875......	891,257	2,023,733	389,799	707,600	6,365,462
1876......	992,764	1,868,961	533,191	785,383	6,555,997
1877......	1,015,087	2,066,594	569,618	682,776	6,608,664
1878......	1,111,110	2,301,215	731,977	788,112	6,381,051
1879......	1,375,691	2,741,853	935,273	993,993	5,995,337
1880......	1,908,745	3,835,191	1,247,335	1,305,212	7,749,233
1881......	2,306,505	4,144,254	1,588,314	1,646,518	8,144,449
1882......	2,965,412	4,623,323	1,736,692	1,507,851	8,586,680
1883......	2,353,288	4,595,510	1,673,535	1,214,905	8,529,300
1884......	2,518,692	4,097,808	1,550,879	1,022,188	7,811,727
1885......	2,466,372	4,044,526	1,711,920	976,978	7,415,469
1886......	3,568,022	5,683,329	2,562,503	1,600,537	7,009,754
1887......	4,730,577	6,417,148	3,339,071	2,139,640	7,559,518
1888......	5,063,693	6,489,738	2,899,440	1,403,700	7,998,969
1889......	7,292,754	7,603,642	3,385,732	1,522,204	8,322,824
1890......	9,012,379	9,202,703	4,277,071	1,885,307	7,904.214
1891......	7,062,233	8,279,870	3,904,240	1,307,176	7,406,064
1892......	9,069,556	9,157,000	4,927,581	1,551,844	6,709,255
1893......	6,060,492	7,124,502	4,019,995	1,136,458	6,976,990
1894......	7,748,932	6,657,388	4,412,032	1,021,772	7,427,342

In my annual report for 1892 I presented a table which gave the production of pig iron and steel in all countries in 1890, or in the latest years for which complete statistics were available. This table showed that this country's percentage of the world's production of these essentials of modern civilization was then as follows: pig iron, 33.9 per cent.; steel, 34.7 per cent. It is reasonably certain that our proportion of the world's production of both pig iron and steel in 1895 will be as large as in 1890, notwithstanding the progress that Germany and some other countries have made in the meantime in developing their own iron and steel industries. Our production of pig iron in 1895 will exceed 9,000,000 tons, and our production of steel will considerably exceed 5,000,000 tons.

The magnitude of our iron and steel industries may also be seen in the statistics for the census year 1890. The whole number of establishments engaged in the production of pig iron, the production of crude steel, the rolling of iron and steel, and the production of iron blooms and billets in the United States in the census year 1890 was 719; the capital invested was $414,044,844; the number of employees was 175,506; the amount of wages paid was $95,736,192; the miscellaneous expenses amounted to $18,214,948; the cost of materials used was $327,272,845; and the value of all products was $478,687,519. If a census of our iron and steel industries were taken to-day, it would be found that the foregoing figures would be greatly increased. The statistics given do not include the operation of our iron-ore mines, which are an essential part of our iron and steel industries, and which in the calendar year 1889 employed $109,766,199 of capital and 38,227 employees. Nor do they include the capital invested and wages paid in the production of coal and the manufacture of coke for use at our iron and steel works.

The iron and steel industries of this country, as well as all other productive industries, were greatly depressed during 1893 and 1894, owing to causes which need not here be explained. In the closing months of 1894 the demand for iron and steel increased, but prices did not advance, nor was there any notable advance in prices until after the close of the first quarter of 1895. Soon after the beginning of the second quarter an increased demand for iron and steel and a rapid advance in prices occurred. During the period from May to October the iron trade of this country experienced all the conditions of a genuine boom. The demand for all products except steel rails was active and persistent, the demand for structural steel being abnormally great. Even the demand for steel rails increased. Prices of pig iron and of some of the heavier forms of finished iron and steel advanced during this period 40, 50, and 60 per cent. About the middle of September the extraordinary demand began to slacken and most prices began to weaken, the reaction, which was of moderate proportions and wholly devoid of excitement, continuing through October. In September and October the furnaces and rolling mills and steel works were, however, as busy as they could be in filling old and new orders. In November and December the slackening in demand has been more pronounced, and prices have been weaker, although still far above those which prevailed in the first quarter of the year. While the iron trade is still in a condition of healthy activity, with fairly remunerative prices, the boom of last summer is ended.

During the early part of 1896 our iron and steel manufacturers will be engaged in filling many orders already on their books. Nor will they lack new orders in the new year. The impetus that the iron trade has received in 1895 will certainly extend into the immediate future. Demand may not in 1896 be what it has been in 1895, and prices may be lower than they now are, but a great shrinkage in either demand or prices is not probable. Prices may indeed rise. Nobody expects from any cause a recurrence in 1896 of the depressing conditions of 1893 and 1894.

The abnormally low prices which prevailed in 1893 and 1894 and down to the second quarter of 1895 should not again be possible. During the recent depression the best furnace coke that this country can produce was sold on cars at 85 cents per ton of 2,000 lbs., and the best Lake Superior bessemer ores were sold at less than $3 per gross ton delivered at Cleveland. These are leading raw materials in the manufacture of pig iron. If they had not been sold at the low prices mentioned, the prices of pig iron, steel billets, steel rails, and other iron and steel products could not have fallen so low as they did.

Now, what may reasonably be predicted of the more remote future of our iron and steel industries? I have shown how rapid and substantial has been their development since 1860, how courageously we have invested our capital in establishing new branches of these industries, how promptly we have adopted new methods of manufacture, and how quickly we have responded to the demand for iron and steel for new uses. It may be confidently assumed that our iron and steel manufacturers will not rest upon the record of present achievements; they will meet the mechanical and commercial problems of the future as they have met those of the past.

I assume that the protective policy of our fathers will be maintained in sufficient force to preserve the home market for the home producers of iron and steel, as well as for the producers of other products. Will that market continue to consume our iron and steel products in quantities sufficient to maintain our iron and steel industries in healthy activity, barring, of course, periods of industrial depression which no foresight and no legislation can wholly guard against? To be more exact, will the last years of this century and the early years of the next century—and we need look no further—witness a home demand for iron and steel comparable to that of 1895?

I think that there can be no doubt that the recently-developed use of steel in the construction of public and private buildings will continue to grow from year to year. Not the least among the advantages claimed for structural steel is its cheapness. We will continue to turn out a large annual product of steel rails, but chiefly for renewals and extensions of track already laid, and not chiefly for the construction of new railroads, or of electric railways for local passenger traffic, important as both these sources of demand must continue to be. There will be an increased demand for iron and steel for use in the building of cars and locomotives and for the various appliances of electric roads. Steel will continue to be a favorite material in bridgebuilding. Whether we greatly increase our naval equipment or not, we will continue to require large quantities of steel in the construction of lake and ocean vessels. Our new tinplate industry will require continually-increasing quantities of steel from year to year, our steady increase in population of itself contributing largely to this result. The use of cast iron pipe and of wrought-iron and steel pipe must also increase with our increase in population. This increase in population will also enlarge the market for stoves, agricultural implements, and hundreds of other articles composed wholly or in part of iron and steel. Our aggregate consumption of iron and steel must certainly increase as the years roll on.

Except in periods of excitement like that which prevailed last summer, our capacity for the production of iron and steel will be greater than the home demand. This fact, joined to the cheapening of all iron and steel products through competition, has led many of our manufacturers to look to foreign markets to absorb our surplus products or to employ our surplus capacity. An examination of our export statistics for many years shows that this is a delusive hope. In 1871 our exports of iron and steel and of manufactures thereof amounted to $14,185,359; in 1879, to $14,223,646; and in 1886, to $14,865,087. Thus for fifteen years our export trade in iron and steel made no progress. After 1886 it increased rapidly every year, until in 1891 it aggregated $30,736,507. Declining to $27,900,862 in 1892, it has since increased, the figures for 1894 amounting to $29,943,729. In all these years the principal item in our export iron trade has been "machinery," which amounted to $10,512,576 in 1893 and $10,715,520 in 1894. The items of next importance are builders' hardware and sewing machines, which together aggregated nearly $5,000,000 in each of the years 1893 and 1894. Saws and tools, locomotives, and wire come next in the order named, each item amounting to over $1,000,000 in each of the years mentioned. In each of these years, low as our prices were, our exports of pig iron were less than $400,000 in value, our exports of plates and sheets were less than half as much, our exports of all kinds of nails averaged about $500,000, and our exports of iron and steel rails averaged about the same amount. The remainder of the total exports of iron and steel and manufactures thereof in these two years was composed of a long list of miscellaneous articles, the direct product of our rolling mills and steel works forming an infinitesimal part.

It is evident that our iron and steel manufacturers, as contradistinguished from the manufacturers of machinery, hardware, saws and tools, sewing machines, locomotives, and other finished articles, have little to hope for in foreign markets under present conditions or those which have recently prevailed. The reciprocity treaties which were in force from 1891 to 1894 did not notably help them. Our very low prices in 1893 and 1894 did not notably add to the exports of previous years. The countries with which we had reciprocity treaties are very small consumers of pig iron, bar iron, plates, sheets, rails, and structural materials, while in other than reciprocity countries our low prices were usually met by the still lower prices of European ironmaking countries.

If we are ever to greatly increase our exports of iron and steel, or of many other manufactured articles that might be mentioned, we must first establish regular lines of steamship communication with other countries, as Great Britain and some Continental countries have done, and next we must establish commercial agencies in the leading markets which are reached by these lines. We must also complete the Nicaragua canal. All these helps must be the work of time. Even then, as in the past, we must depend for foreign customers rather upon the superiority of our products than upon their cheapness. Reciprocity treaties, which throw away revenue that the country needs, and which have confused the public mind in the effort to distinguish the difference between them and absolute free trade, offer no commercial advantages to our iron and steel manufacturers that are worthy of serious consideration.

It follows from what has been said that American iron and steel manufacturers must look almost entirely to their own country for the employment of the productive capacity of their iron and steel works, and that, if this capacity can not all be profitably utilized, some of it, as in the past, must stand idle or be abandoned. The fittest works will survive. For these there will be sufficient employment.

ARE AMERICAN RAILWAY RATES TOO HIGH?

By H. T. Newcomb.

EXCEPT between the comparatively few localities connected by waterways (and excluding, for the moment, transportation by animals), railways furnish the only means of transportation cheap enough to be practicable in connection with productive industry as now organized. Prior to their introduction, the market for surplus agricultural products was confined within narrow limits by the excessive cost of movement. Over one of the best of the old turnpikes it cost $1.00 in 1807 to transport a barrel of flour weighing 200 lbs. 74 miles from Columbia, Pa., to Philadelphia. It is now possible to ship 500 lbs. of flour by rail from Chicago to New York, 912 miles by the shortest route, for the same sum. The reduction from 13½ cents to 4½ mills per ton per mile is from a rate absolutely prohibitive, for the longer distance, to one at which the entire surplus product of an area greater than the whole of Europe can be profitably shipped.

The progressive reduction in rates since the introduction of railways, which has been very great, is best illustrated by comparisons between the prices of various commodities during successive periods and the rates contemporaneously charged for their transportation. The average export price of flour was $5.88 per barrel in 1880, and $4.11 in 1894, and the average rate from St. Louis to New York 84 cents and 50 cents respectively during the same years. Comparing prices and rates, it appears that in 1880 freight charges absorbed the value of 1 barrel in every 7, but in 1894 only 1 in every 8.22. The average export price of wheat during 1868 was $1.90 per bushel, and the average rate for its transportation by rail from Chicago to New York 42.6 cents, or 22.4 per cent. of the price. Although the price for 1894 was unprecedentedly low, being only 67 cents per bushel, or 20 per cent. less than during the lowest previous year, the decline to 12.88 cents per bushel for transportation from Chicago to New York was still greater, the rate for the latter year being only 19.2 per cent. of the price. The average New York price of mess pork during 1893 was $18.35 per barrel, or 83 per cent. of the average for 1867, while the cost of bringing it by rail from Cincinnati in the latter year was but 36 per cent. of that in the former. The average rate per ton per mile charged for the transportation of anthracite coal over the Lehigh Valley railroad during 1874 was 2.21 cents; 1880, 1.43 cents; 1885, 1.22 cents; 1890, 0.84 cent; and during 1893, 0.82 cent. Comparing these rates with the annual average prices of anthracite coal in Philadelphia, as given by the American Iron and Steel Association, it appears that the cost of transportation would have doubled its price at a distance of 206 miles from Philadelphia by rail in 1874, at 336 miles in 1885, and at 476 miles in 1893.

The average charge for carrying a ton of freight one mile *via* thirteen of the most important railways in the United States during 1865 was 3.08 cents; 1870, 1.80; 1875, 1.36; 1880, 1.01; 1885, 0.83; 1890, 0.77; and 1893, 0.76 cent. These railways performed one-third of the entire freight transportation during 1893, and from the figures given it appears that 76 cents would pay for as much transportation over their lines in 1893 as could have been obtained for $3.08 twenty-eight years earlier. This reduction, amounting to three-quarters of the average rate for 1865, has been exceeded by that in the price of but few even of those articles in the manufacture of which new inventions have worked the most radical changes. For the present purpose of comparing freight rates with contemporary prices it is unnecessary to reduce currency rates (prior to the resumption of specie payments in 1879) to the gold basis; but in considering the absolute reduction in rates the proper allowance should be made.

The entire transportation performed by the railways of the United States during the twelve years ending June 30, 1894, was equivalent to moving 136,799,677,822 passengers and 807,935,382,838 tons of freight one mile. Had rates averaging as high as those of 1882 been collected upon this traffic, the railways would have earned $2,629,043,459 more than they actually received. Had the amounts annually saved by the public through reduced charges for moving passengers and property been applied to paying the principal and interest of the national debt, which on July 1, 1882, amounted to $1,463,810,400 (estimating interest from that date at 4 per cent. per annum, which is higher than the average actually paid), it would have been extinguished some time during the fiscal year 1893, and the surplus accumulated since that date would have amounted to nearly $700,000,000. The obvious answer to such an estimate as the foregoing is that the increase in traffic which has taken place during the last twelve years would have been impossible at the rates of 1882. Admitting the force of this contention, it is interesting to observe that, had the amount of traffic remained during each of the succeeding years what it was during 1882, the difference between the cost to the people of its transportation at the rates actually charged and the cost at those of 1882 would have amounted to a saving upon the part of the public of $1,452,148,093, or a little more than 99 per cent. of the amount of the entire national debt on July 1, 1882. Had traffic increased half as much as it actually did, the saving to travelers and shippers would have been $2,040,284,477.

The constant pressure for concessions in the price of transportation upon those railway officials whose duties include rate-making is enormous. A reduction of a few cents will often open new and valuable markets to the products of particular localities, and, if not immediately balanced by corresponding reductions in rates from other sources of supply, may enable their shippers to monopolize what was formerly a common market. Consequently a single reduction must often be met by numerous others from points widely removed and frequently in an opposite direction from the market. Competing shippers in the same locality are always endeavoring to obtain more favorable rates than those granted to their rivals, and thus secure an advantage which not infrequently amounts to the difference between a gain and a loss. The use of particular commodities is often limited territorially by the freight charges from the point of production to those of consumption; and, when charges are too high on certain articles, substitutes produced nearer the points of consumption, or carried at lower rates, are frequently used. Similarly, the charges for passenger transportation, by limiting the distance to which agents can profitably be sent and otherwise hindering personal communication, effectively prescribe the limits of practicable interchange of commodities. Naturally, then, we find the entire force of commercial competition, possibly the most tremendous product of modern civilization, arrayed in opposition to the efforts of railway managers to maintain their charges at profitable figures.

A very large portion of railway traffic is obtained in competition with carriers making use of natural waterways and canals. For example, the grain traffic from Chicago eastward can be obtained during the greater portion of the year only at rates low enough to prevent its going to the numerous lake and canal lines. It is not surprising, therefore, that the normal rate on this traffic by rail from Chicago to New York amounts to only about four mills per ton per mile, and that in times of particularly strenuous competition it has been temporarily as low as two mills. In addition, the deplorable tendency among traffic officials to seek increased tonnage without sufficient regard to the cost of handling it, coupled, as it is, with the frequently unfortunate lack of intimate connection between the traffic and operating departments, must be given considerable importance in any attempt to measure the forces that tend to reduce charges.

No one can investigate the history of railway charges in the United States without reaching the conclusion that they tend constantly toward a minimum, retarded only by the feeble effort of officials who are are often more concerned to obtain traffic than to make the business of transportation profitable. This minimum is the point at which the revenue produced will pay operating expenses and leave something, however little, as a recompense to invested capital. Rates cannot go permanently lower than this, because, if they do, operation will be discontinued. That they tend toward it is clearly indicated by the record of decreasing returns.

Though the railway system of the United States increased from a total length of 114,712 miles in 1882 to 178,709 miles on June 30, 1894, or 56 per cent., the aggregate sum paid in dividends during the latter year was only $95,575,976, being $6,455,458, or 6 1-2 per cent., less than during the former. This did not result from a transformation in the form of capitalization, though the percentage of funded debt to total capital is somewhat larger at present than in 1882, for stock cap tal increased over 30 per cent. in the same period. It is obvious that so great a reduction in the average amount of interest paid on bonds could not be contemporaneous with a reduction in dividends, as the uncertainty of return indicated by the latter would naturally tend to increase the rate of interest demanded. Some decrease, however, has taken place, as is shown by the fact that an increase of 72 per cent. in the aggregate of funded debt from 1882 to 1893 was accompanied by an increase of but 55 per cent. in the amount of interest paid. During 1871 railway dividends throughout the United States averaged $1,265 per mile of line operated; this average has steadily declined to $988 in 1881, $565 in 1891, and $557 in 1894. During the year ending June 30, 1894, railway stock having a par value of $3,660,150,094, or 63 1-2 per cent. of the total, received no dividend,—a larger amount, both actually and relatively, than during any year since the Interstate commerce law was passed. In the same year no interest was paid on 14 per cent. of all mortgage bonds, 12 per cent. of miscellaneous obligations, and 87 per cent. of income bonds. On the same date 192 railway companies, operating more than 42,000 miles of line and representing one-fourth of the total railway capitalization, were in the hands of receivers. During the three years ending December 31, 1894, receivers were appointed for railways having a total length of 46,873 miles capitalized at $2,534,529,000; and 9,178 miles, capitalized at $494,821,000, were sold under foreclosure. From January 1 to July 1 of the present year these totals were increased by 2,409 miles capitalized at $149,615,000 and 2,396 miles capitalized at $100,941,000, which, respectively, went into the hands of receivers and were sold under foreclosure. According to the preliminary report of the statistician of the Interstate commerce commission for the year ending June 30, 1894, the income of the railways in a section including 52 per cent. of the area of the country did not produce enough above the actual cost of operation to pay their fixed charges during that year.

These statistics of decreasing returns to investors, financial disaster, and widespread insolvency clearly indicate that the present railway charges are not too high, unless it is desirable to reduce all railway corporations to a condition of uniform and hopeless bankruptcy, even if they do not demonstrate, as might be urged with some evidence of justification, that the returns now produced by railway rates are actually lower than is reasonable and just.

There is no public interest which demands that railway rates shall be so low as to be unremunerative. Too low charges invariably result in the speedy impairment of railway service through the deterioration of road-bed and equipment and the reduction of the efficiency of the safeguards against accident usually provided, thus increasing the danger to person and property. The expenses due directly to handling traffic and moving trains are much less elastic than those incurred for keeping up the quality of track, rolling stock, and signaling apparatus ; and, when depleted revenues enforce upon railway managers the necessity of immediate retrenchment, the latter are most likely to suffer. Thus, when, during 1894, reduced traffic, low rates, and dwindling earnings required a reduction of 93,994, or nearly 11 per cent., in the number of men employed by the railways, nearly one-third of the entire number was taken from trackmen, their number being reduced 16 1-3 per cent. The decrease in the number of employees assigned to the maintenance of way and structures was 16 per cent. ; in those assigned to maintenance of equipment, 13 1-3 per cent. ; while in those assigned to the work of conducting transportation it was only 8 per cent. During the same year the expenses of operation were reduced 11 2-3 per cent. as compared with the previous year. Of the total decrease of $96,506,977 51 per cent. was taken from the expenditures incident to the maintenance of way, structures, and equipment, though these combined ordinarily constitute only about 37 per cent. of the total expense of operation.

Though expedients like the foregoing will frequently be resorted to, and interest and dividends paid by reducing the quality of the service rendered, they are merely temporary and generally extravagant, as physical deterioration soon reaches a point beyond which it may not be allowed to go, and final restoration is then found to cost much more than the total of the amounts which should have been regularly expended for maintenance. Unless revenues can be increased, the cost of such restoration must be taken from the return to investors, or met by new loans, and bankruptcy is the usual and natural result.

The frequent failure of railway enterprises to prove remunerative results in enhanced difficulty attending efforts to secure capital for the construction of new and often much needed lines, and in the exaction of conditions which afford at least a chance of extraordinary profits as an offset for what is regarded as the extra-hazardous nature of the investment. This opportunity for large returns very often takes the form of an excessive discount on the securities offered or—what is much the same thing—a large stock bonus to accompany sales of bonds, these being among the most frequently deprecated methods of "stock-watering."

Practically, it may be declared that the public, considered as distinct from railway owners, must finally pay for all the transportation it receives, and that too low rates between particular points or during a particular period are not desirable, because, if for no other reason, they will inevitably be offset by too high rates between other points or during another period. Nor is this conclusion, as might appear, entirely satisfying to present railway owners, for, long before the period of compensation arrives, their interest may have been destroyed by insolvency, bankruptcy, and foreclosure.

It is apparent, then, that, considered from any reasonable standpoint, the present level of railway rates is too low rather than too high. It is, no doubt, possible to conceive conditions of operation and management different from those now governing, under which economies could be devised radical enough to render much lower rates than those now in force both practicable and profitable. There are many particulars in which railway management as currently practised is extravagant and wasteful, but they are, without material exception, the direct result of the conditions imposed by public sentiment or legislative enactment. Just as long as the public sees fit to impose upon reluctant railway owners and managers the burden of unnatural and needless competition, which is beneficial to no one unless it be to soliciting agents, ticket scalpers, and other railway parasites, it should accept without murmuring the enhanced charges which it must pay for transportation, and the frequent losses from business depression of which railway bankruptcy is a prolific cause.

The various enactments of State legislatures intended to erect obstacles in the path of railway consolidation, the numerous provisions against the union of competing or connecting lines contained in railway charters, and, above all, the Interstate commerce law with its obnoxious anti-pooling section, have all had the uniform effect of forcing upon railway managers objectionable and non-economic methods, and of compelling the public to accept the alternative of charges higher than would be necessary under better conditions or of seeing the greatest agency of modern civilization reduced to hopeless insolvency.

Authentic statistics of the amounts wasted in the struggle for traffic between rival railways are exceedingly difficult to obtain, as the efficiency of most of the methods resorted to in the effort to divert traffic from rival carriers depends very largely upon the degree of secrecy attained in their execution, and for the further reason that many of these practices have been rendered illegal and penal by statute. Among the most frequently deplored results of competition is the practice of paying large commissions to influence the routing of traffic in favor of particular lines. The abolition of this practice, which has been a prolific cause of "rate-wars," has been often attempted, but it has never passed into entire disuse, and, as long as competition continues, will probably be one of its ordinary weapons. According to a report made by the Interstate commerce commission as the result of a special investigation of the subject, nine railways expended the sum of $1,097,130 for commissions during a single year.

The multitude of outside agencies and travelling and other soliciting agents involves another considerable expenditure that is solely due to competition. Their only object is to secure passengers and freight for their respective lines, and their cost is so great, even during seasons of comparative harmony, that it has often been found necessary to restrict their number by contract.

The economic waste arising from the competition of long, circuitous, and expensive routes for traffic that would naturally go by more direct and consequently cheaper routes is incalculable. Freight traffic between New York and New Orleans furnishes a ready example, though not by any means an extreme instance of this form of extravagance. It is actively sought by numerous lines operating entirely by water, or by water to the ports of Norfolk, Savannah, Charleston, etc., and thence by rail; and the rates obtainable are in consequence extremely low. Yet, in spite of this fact, nearly one hundred all-rail routes are known to seek actively to secure it. Of these the shortest and most direct is by way of Philadelphia, Baltimore, Washington, Lynchburg, Bristol, and Chattanooga, the entire distance being 1,340 miles. In contrast with this, the longest route, involving a haul of 2,051 miles, is by way of Buffalo, New Haven, Indiana, St. Louis, and Texarkana. Estimating the cost of running a train these distances at the average cost per train mile given by the statistician of the Interstate commerce commission in his latest annual report, the cost for the shorter distance is $1,431 and for the longer $2,190,—an excess over the minimum of necessary expenditure, for each trainload carried over the longer route, of $759, or 53 per cent. This illustration is fairly typical of the entire system of competitive railway transportation. While it may be true that the shortest is not necessarily the cheapest route, it cannot be doubted that a considerable saving would accrue from forwarding all traffic over whatever routes should be found, after careful experiment, to be the cheapest; but this can never be fully accomplished until the ruinous competition of to-day is restricted.

Competitive train service, both passenger and freight, is also a fruitful source of extravagant expenditure, which is not accompanied by any corresponding increase in the accommodations offered the travelling and shipping public. The cost of moving a passenger train from Chicago to Omaha at the average cost per passenger train mile for the roads operating between those points reported by the Interstate commerce commission is $423, and, if their number could be reduced one-half, which appears by no means impossible, the annual saving would amount to $1,499,958.

Very similar causes result in a failure to utilize rolling-stock equipment to anything like its full capacity. The amounts wasted in the construction of cars and locomotives that would be unnecessary if rolling stock were used to its full capacity can scarcely be estimated. That it is considerable is as evident as that the practice of light loading is the direct result of competition.

Railway managers have attempted in many ways the abolition or adequate restriction of competition, but no method ever devised, short of actual consolidation, has proved as effective and satisfactory as that somewhat erroneously termed "pooling." Against this custom, when it existed, was directed much popular antipathy, which was fostered and encouraged by every demagogue who saw advantage to his personal interests in availing himself of the strength of an unreasoning prejudice, and it has been forbidden by State and national legislation; but it is now coming to be universally recognized that evidence justifying such popular distrust and suspicion is wholly wanting.

AN ENGINEER'S LIFE IN THE TROPICS.

By Charles P. Yeatman.

AS a rule, it may be said that an engineer, in going to the tropics, risks physical and moral bankruptcy for the sake of bettering his financial condition. Of course, temperature and climatic conditions vary greatly with the height above sea-level, and what is true of the low land, with its swamps and tropical jungles, does not apply to the mountains and high plateaus, which have rapid drainage, and cool atmosphere, and are out of the reach of the dreaded yellow fever. Higher still, we reach an altitude which gives trouble to many on account of the rarity of the atmosphere.

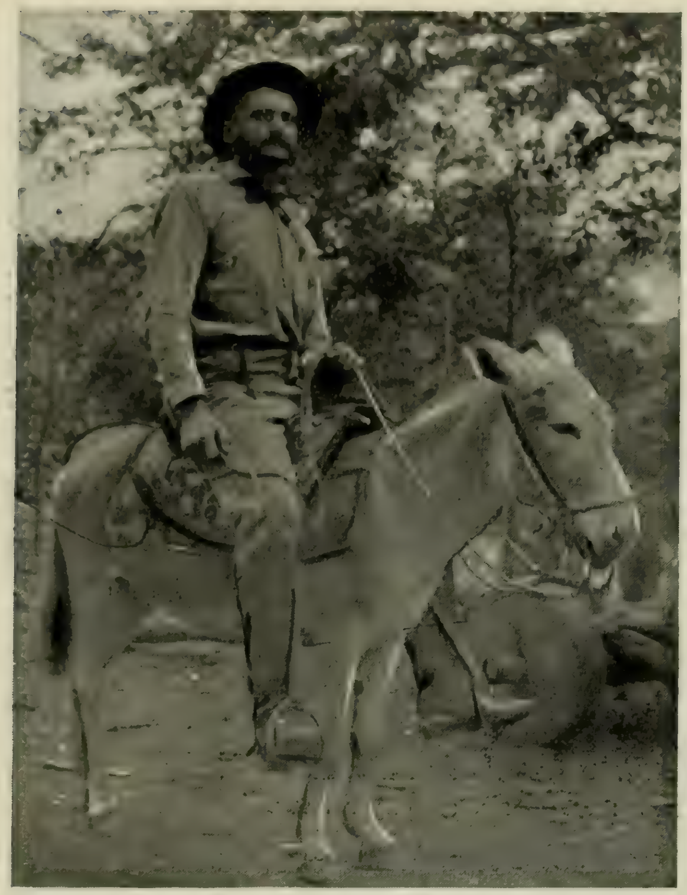
It has been stated on good authority that yellow fever is never endemic higher than 1,500 ft. above the sea, but under favorable circumstances, where rapid transportation exists between a coast town and one in the mountains, sporadic cases will appear so frequently in the high town that the germs become acclimated in time, and take up their permanent residence in an altitude of at least 3,000 ft.

The safest place for the foreigner in the tropics lies between 3,000 and 6,000 ft. above sea-level, but even at that height irrigation, that artificial swamp-maker, may bring miasma to his door, and thoroughly weaken his system and impoverish his blood. At the height of 8,000 ft. some persons do not have a continuous week of perfect health in years ; yet a few days in a lower altitude gives relief. At over 10,000 ft. many persons are affected by shortness of breath on exerting themselves, if not by palpitation of the heart.

As these countries first need railroads to the interior from the seaports or points on navigable rivers, the engineer's experience is very apt to be on comparatively low land. Even when one resides on high land in the tropics, New York insurance companies charge 46 per cent. more to insure his life (supposing him to be 25 years of age) than they would if he lived twenty-six degrees or more from the equator. At 40 years of age the extra premium is 37 per cent.

Concerning risks to life in low tropical districts, the following extract from a letter of instructions to the agent of a first-class insurance company may be of interest.

"If the applicant who is going to the low lands is entirely unacclimated to tropical countries, or to be much of the time in the low land, or, indeed, if he is to be any of the time during the hot portion of the year in places below 1,000 ft. above sea-level, his acceptance at all would be doubtful, because a costly experience has shown us the



A MOUNTED ENGINEER.

danger of accepting persons going from high northern latitudes to reside in the tropics, away from the restraint of their families, and where, in the event of their being attacked by sickness, they will not receive the same attention that they would at home.

"If accepted at all, the case would have to be most favorable in respect to temperance and other qualifications necessary to make the risk above the average, in view of tropical residence, and the extra premium would be 4 per cent. the first year, 3 per cent. the second year, 2 per cent. the third year, and 1 per cent. the fourth year, over and above the tropical rate, as published in the table."

From my own personal experience, I can not say that the insurance companies make an unjust difference in their charges. In going over a list of eighteen foreigners with whom I was acquainted while on my first tropical work, I found that fourteen of them died within about ten years. I know nothing about the other four. Of these eighteen, sixteen were Americans and two were Englishmen.

It is commonly said by foreigners who live in the tropics that it is necessary to drink a large amount of liquor in order to preserve health. With all due respect for the honesty of such opinions, I must enter a decided protest against them. While admitting that a limited amount of liquor for a short time may stimulate the system enough to enable it to cast off contagion temporarily, it must be remembered that, to be efficacious, the amount must be increased as time passes, until the remedy itself may become more to be feared than the disease. The natural ability of the constitution to resist illness becomes undermined

OUR FRONT CHAINMAN ON FEAST DAYS.

OUR MARKET BOY.

by a steady and excessive use of alcohol, so that, when a remittent fever comes, and the stomach refuses to retain the alcohol, there is apt to be a collapse of the patient.

While this is true of liquor taken continuously as a medicine, it is even more dangerous when taken recklessly to drown fear. The native of the tropics who was born and reared on high mountain land has more reason to dread the fevers of the low lands and coasts of his own country than has the foreigner from the temperate zone. The former never in his life felt hot weather, and his first experience is likely to have a very weakening effect, while the latter has probably experienced more heat during a part of every summer of his life than he will find in the tropics.

The richest and largest cities in the tropics are often in the interior, at a considerable height above sea-level, and not the least objection to foreign travel, to those living in such cities, is the fear of dying in the hot part of their native land, before getting out of it.

TWENTY CENTS WORTH.

I remember that, shortly after arriving in the town of Girardot, on the Magdalena river, I had to make a trip of about forty miles to a town in the interior. On the way I met an intelligent looking traveler from the "cold land," as they call it, who was hardly able to sit on his mule, and was very hilarious. At the next tavern I inquired about him, and was told with a smile that he was a doctor from the interior, who was on his way to Europe, and was so afraid of the "hot land" fevers that he intended to keep drunk until he was well on the ocean, as the surest means of preserving his health.

BAMBOO FALSEWORK.

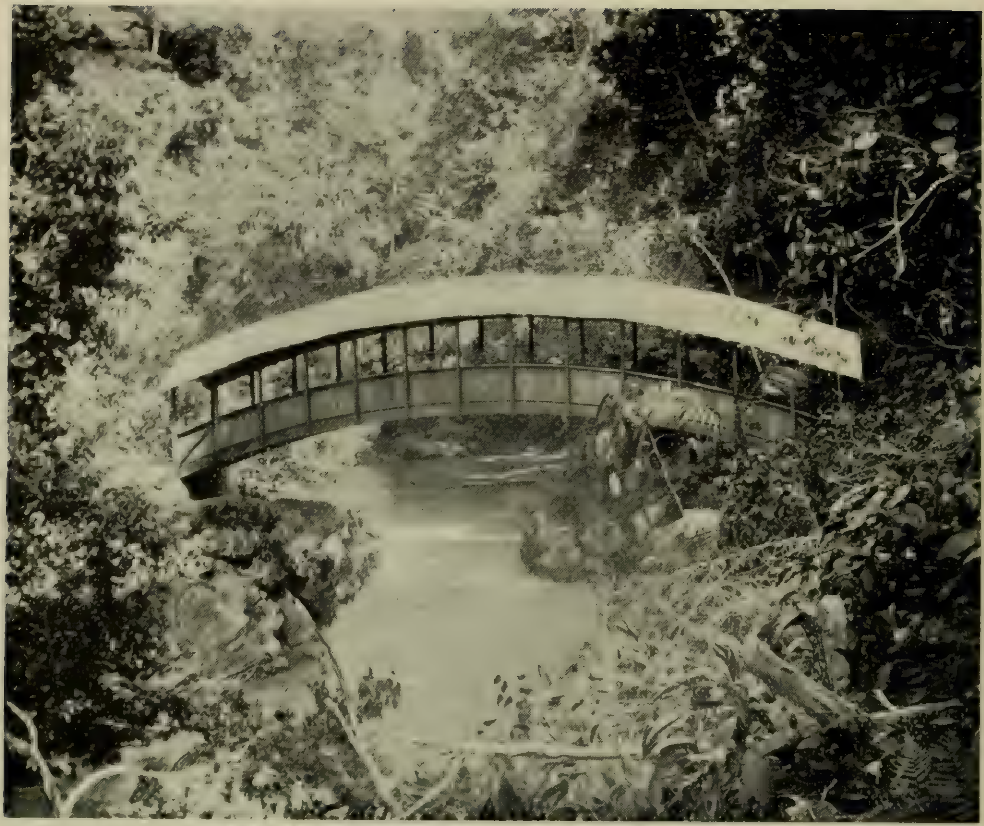
PILE TRESTLE—HONDA.

On my return two days later the efficacy of alcohol as a panacea for fevers had been already settled in his case. He had been buried that morning, and his effects were in the hands of the town authorities, who had already notified his friends by telegraph. He arrived at night, ate and drank plentifully, and woke up in the morning under the influence of both liquor and fever. As the fumes of the former died down, the delirium of the latter took their place, and at daybreak the next morning he was buried. His journey through the low land had only begun, for he died at twelve hundred feet above sea-level, and seven hundred miles from the coast, which he would have spent ten days in reaching. This was by no means a solitary instance during the two years which I spent in that part of the country. On the other hand, those who passed through soberly and in order escaped burial, at least.

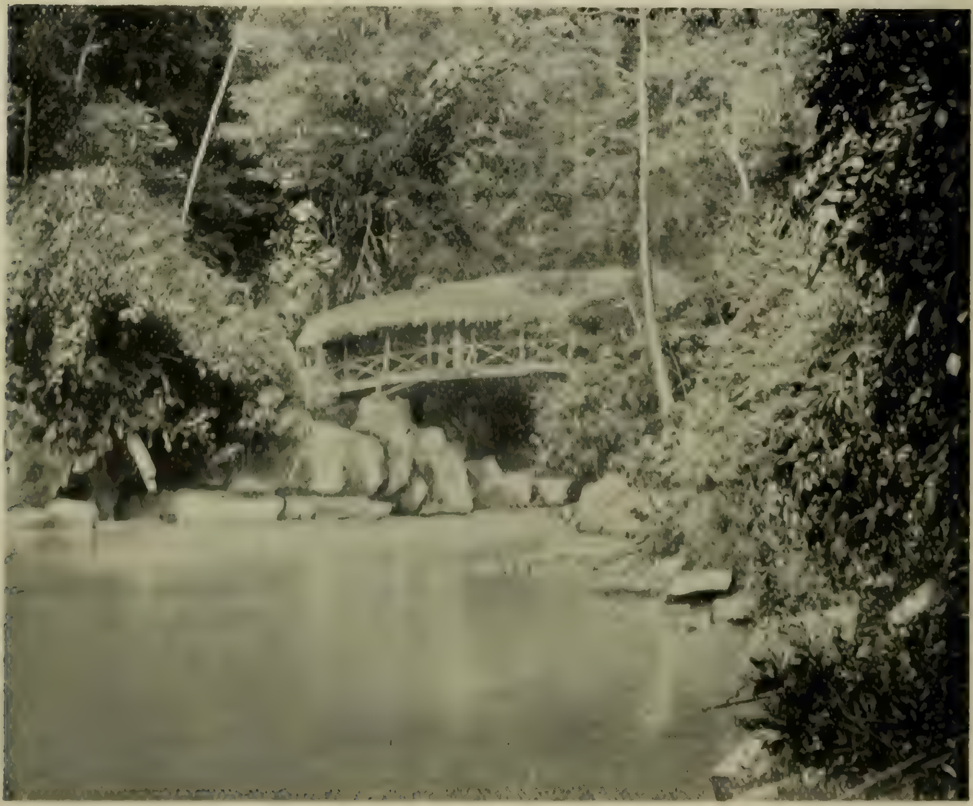
The difficulties in the way of the civil engineer in the tropics are apt to be many and various. Well I remember my first official trips for construction work on a Colombian road. Five miles of track were said to have been laid, four miles of grading extended beyond it, a contractor was ready with men to continue the grading, and I had orders to put in stakes for the earthwork.

ALONG THE MAGDALENA.

After the first meal of the day, which is a cup of coffee and a piece of dry bread at six o'clock, I expected to find a train, or a hand-car, or at least, a push-car, ready for the trip as far as the rails were laid. I was a little surprised to find a couple of mules, saddled and bridled, for my rodman and myself. It then transpired that the track was not navigable even for push-cars, for the ties were so rotten in many places

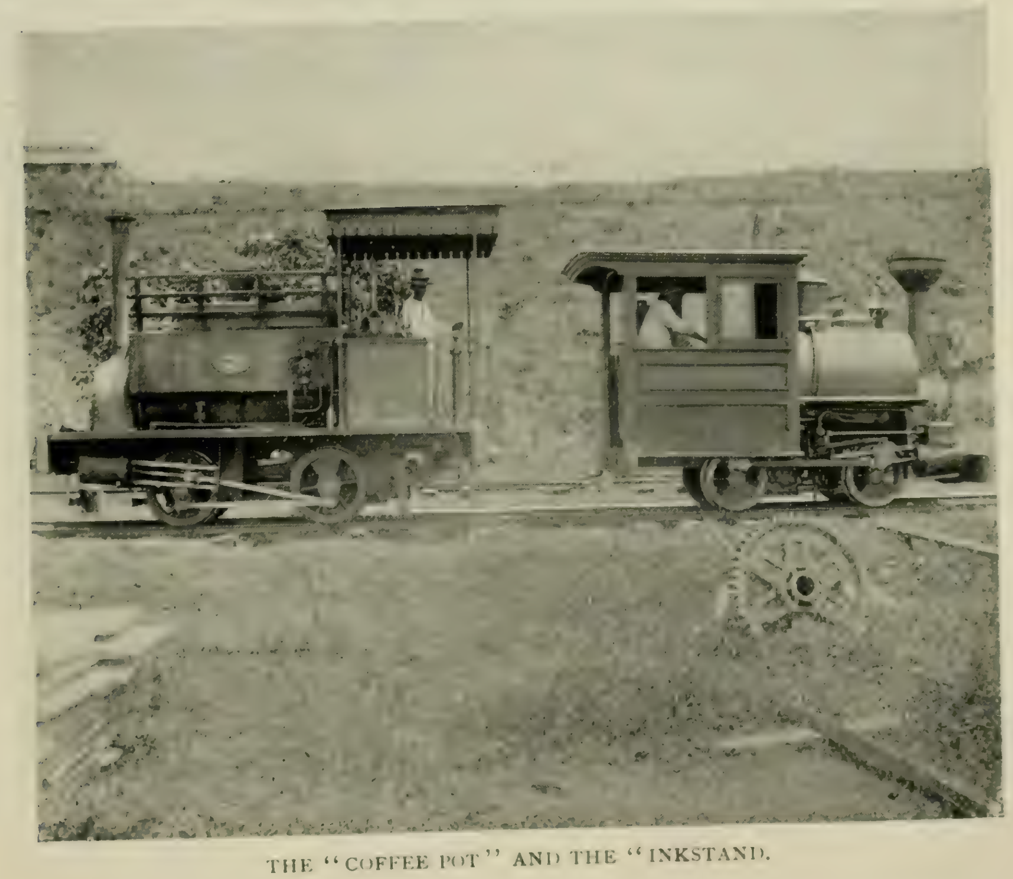


MULE-ROAD BRIDGE, WITH CORRUGATED IRON ROOF.



THATCHED BRIDGE OVER THE NUS RIVER.

HERE BEGINS THE TRAVEL BY PACK-MULES.



THE "COFFEE POT" AND THE "INKSTAND.

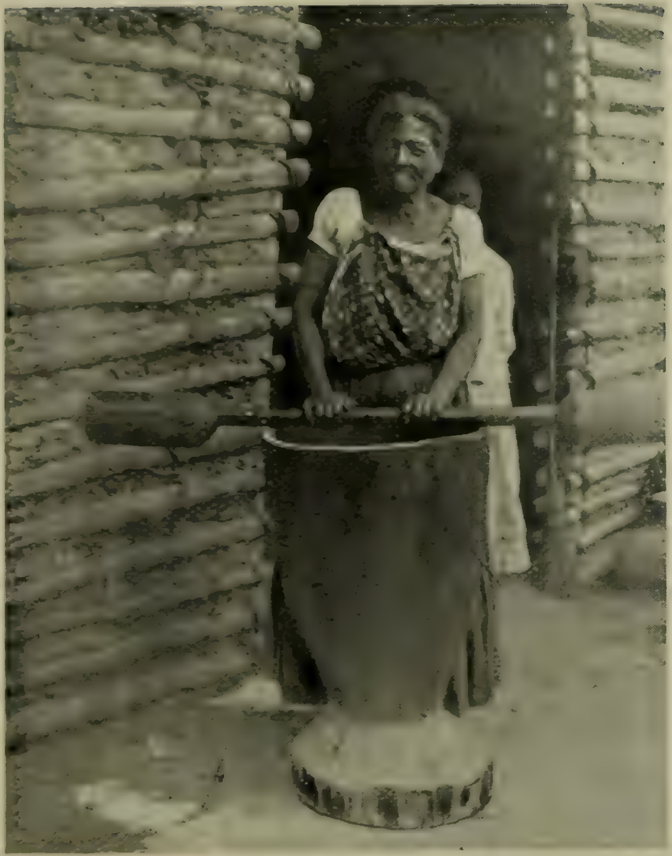
CEMETERY IN HONDA, COLOMBIA.

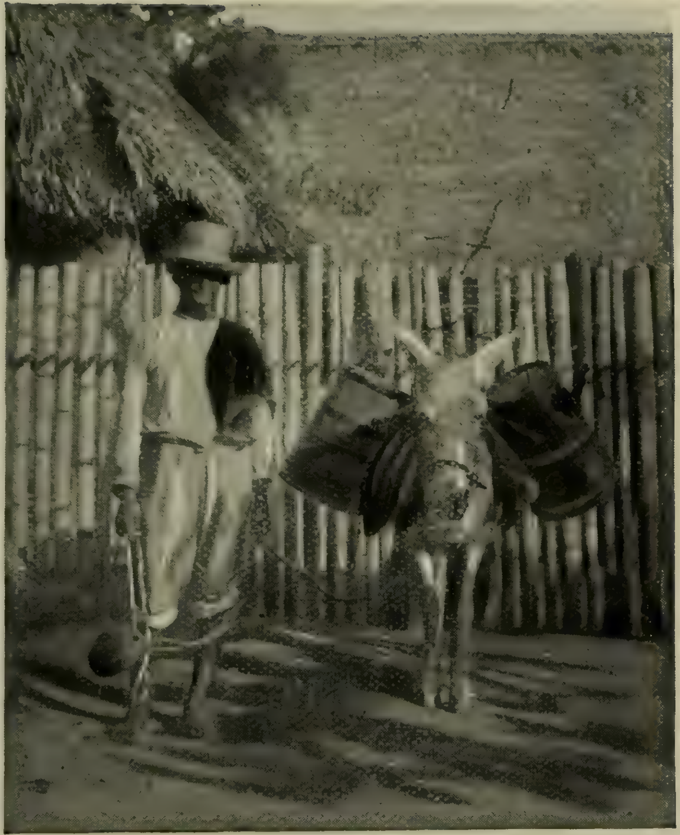
THE PLAZA—HONDA.

that the spikes no longer held, and the 35-lb. rails had a bad habit of spreading and letting the car drop in between them.

I soon learned what a serious hindrance this would be to the progress of the car. The track was the only road for cattle and mules coming from the interior, and an impenetrable thicket walled in each side to the very ends of the cross-ties; so there was no choice for animals but to walk between the rails. This sort of traffic was so constant that the spaces between the ties had become deep mud-holes filled in part with water, thanks to the rainy season, which was then on in full force. Frequently the soft mud in these holes was too deep for the draft of the mule, and he made a rainbow of his spinal column to reach bottom on both sides of a tie at once. If that was not successful, he would balance for a moment on the tie, then kick up his hind feet till he almost stood on his head, and in that position would attempt to get his rear feet into the same hole in which his front feet were planted. If he succeeded, he would gather his energies together, and make a buck upward, like the mustang in Buffalo Bill's show; only he would open out in the air with the evident idea of getting his fore feet on the other side of the next tie. At times he would become desperate,

RUINS OF CONVENT. DESTROYED BY EARTHQUAKE OF 1805.


THE OLD COOK.


WATER FOR SALE.

WHERE THE BREAD WAS BAKED.

AN INDIAN MAKING STRING.

TROPICAL FOLIAGE.

A RAINY DAY.

and attempt to walk on top of the ties, but quick and sure disaster always followed.

Soon we arrived at a pile trestle over a narrow stream with perpendicular banks. A single line of plank twelve inches wide, spiked to the ties in the center of the rails, extended the length of the trestle. When my mule arrived at this point, he began to climb upon the plank, whereupon I slipped down into the mud. The mule stopped, and my companion told me that that animal would not cross a trestle without a man on his back, and that his own mule would never go across first. I looked at the water twelve or fifteen feet below; it was evidently deep, and the current swift. The ties were two feet apart and about six feet long. The plank was wet and slippery, and I thought that there must be either a misunderstanding or an attempt at a practical joke.

It might be well to explain here that I knew very little Spanish, and my comrade just as little English, and what either did know he did not pronounce as the other was accustomed to hear his native tongue spoken. In fact, I had spent the greater part of one evening learning from this same young man what I thought were Spanish words, until by chance I discovered that he thought I was finding out how much English he knew, and he was giving me his version of my own language.

I tried to lead my mule gently over the plank and then to drive him; then Martinez tried to ride him over; but by that time he was stubborn and would not go, although his new rider was armed with spurs whose rowels were about the size of a small dinner plate.

We held a council of war, and decided to push the mules off the top of the embankment and force them to swim the creek. The first one landed in the bushes with his nose over the water's edge, but backed and tried to climb up the bank. Martinez meant to kick him on the shoulder, but aimed too high, and, as his foot came down, that big spur caught over the mule's neck in front of the saddle. The animal jumped forward, dragging my friend with one foot on high and the other hopping, until the spur strap gave way just as the mule plunged into the water.

After that I walked along the track and drove my mule ahead of me. At short intervals there were trestles to be passed, and there was a hard-fought battle with the mules at every one. This was all because I did not stay on that mule and let him carry me over the first bridge; but at that time such a feat seemed to me like a weak imitation of Blondin on the tight rope.

When we reached the end of the track, I hoped to ride in comfort, but I found that the regular mule road was a series of mud-holes with ridges between them, just as if it had once had cross-ties on it. It was much more exercise to ride than to walk, whenever there was ground above the water to walk on.

We came to a deep-looking creek, with steep and slippery banks, where there was a choice between crossing on a slender log, which nearly touched the water, and trusting to the mule. My friend swam his mule across, but the beast, in climbing up the other side, fell backward on him ; fortunately the water was deep, so that his sole injury was a wetting.

I tried the log and had reached the middle of it, when I remembered having seen a big alligator not far away, and fell off at once. I caught the log with my hands so that I got wet only to the neck, but, in my great anxiety not to discommode the saurian in his native element, I scrambled upon the log and out on the bank from which I had started, and then "cooned" across with my feet dragging in the water.

In crossing a veritable "Slough of Despond," my comrade's mule got mired, and threw his rider over his head, so that he landed at full length in the blackest of slimy mud. When he had splashed out on more solid ground, and clawed the mud off his face, he said some words which I was sure were Spanish.

We arrived at our destination just before sunset in a very demoralized condition. When we started that morning, I hoped to finish our work and return to our starting-point before night. We were informed that, before the grading, etc., was done for the railroad, parties at times spent three days in crossing those nine miles of swamp, the rainy season making some of the rivers impassable so suddenly that they were imprisoned between two streams and could not go forward or backward until the water fell. This was told with an air which said that now the trip was easy and commodious, but I could not help thinking how much more comfortable it might be made.

That night my friend provided me with the regulation floor bed,—a mat three feet by six,—a small pillow, and his own mosquito net. At first I refused the last, as it was all the baggage he had brought, but, when I saw that he was similarly provided for, my conscience was more easy.

I hoped to sleep well, although the ground under my mat was neither smooth or soft, but I soon found that I had bed-fellows, who did not propose to sleep. First came mosquitos, and then legions of larger insects, which ran over me, but did not bite, for which I was thankful. Then I discovered that I was the center of attraction for numerous rats, which ran around outside of my net, as if looking for a place to get in at me.

Once I was wakened by a rat running over my face, and, after chas-ing him out, I carefully tucked the bottom of the net under the edge of the mat on which I lay. After that I slept till morning. Before I crawled out from under my net, I discovered why the rats took such a great interest in me. The inside of my net was covered with roaches, which had taken refuge there to escape from the rats, which are very fond of them.

It is the luck of many who go to the tropics to meet immense anacondas immediately on their arrival, and in many instances the serpents must have been brought a thousand miles or more from their abiding place in the Amazon valley to meet these bold hunters. In ten years' work in the forests, mountains, and plains of Colombia, I have met but three or four large snakes. The largest was thirteen feet two inches long, and six or seven inches in diameter. These snakes were considered perfectly harmless.

There are plenty of poisonous snakes, but people are not often bitten by them ; I know of but one death from that cause. The chief engineer of the Bucaramanga Railway, an Englishman, was bitten on the bare leg while fording a creek bare-footed, and died from the poison.

That year (1893) was an unlucky one for foreign chief engineers in Colombia. The chief engineer of the Cauca Railway was drowned in the Dagua river, that mountain torrent of whose navigation Humboldt wrote that "each canoeman was a god, and each push of his pole a miracle," and the engineer of the Cucuta Railroad had the yellow fever twice, but survived it, much to the amazement of the citizens of that city, who seem to take a pride in the fact that chickens, hogs, cattle, and even mules, imported from this country, die of the yellow fever, with all its symptoms of black vomit, etc.

There are many excellent opportunities for investment of capital in Colombia, but, on account of the depreciated currency, it is not at present a Mecca for civil engineers without foreign capital to back them.

In Venezuela there is a little railroad leading from Lake Maracaibo toward the interior, which in 1892 paid a dividend of 25 per cent. and in 1893 dividends amounting to 40 per cent. of the first cost of the road. The road was built in the cheapest possible manner alongside of the mule-road, and traffic commenced almost at once, giving profit enough to gradually rebuild the old road and prolong it.

A small road near by, in Colombia, paid in the same years 9 per cent. and 13½ per cent., but on a capital which represented no outlay whatever to the stockholders. The road replaced a mule-road on which toll was collected, and the holders of $2,500,000 of stock were never called on for payments. This road was built by Colombian engineers, and had on it considerable expensive masonry.

ARE WE EDUCATING TOO MANY ELECTRICIANS?

By Henry Floy.

REMARKABLE electrical discoveries and a failure to understand the laws which govern electrical phenomena have combined to produce in the public mind an almost superstitious belief in the impossible, or, to put it mildly, a facility for considering the most commonplace fact a profound and fascinating mystery if only joined with the wonder-working word "electrical." As a result, public attention has been unduly attracted to and concentrated upon things electrical; the fad has been increasing, until it has become something more serious; it is a mania,—electro-mania.

As a result, the opinions and lives of many individuals are erroneously shaped, and the effects are becoming so marked that it seems time for those who realize the situation to set about correcting the existing misconceptions. To my mind there is urgently needed an educating of popular thought as to the possibilities of electricity and the business opportunities offered in electrical engineering. Such information must be conveyed by a simple and straightforward statement of facts and of the conclusions that may be logically drawn therefrom.

Having some time ago become convinced of the over-supply and continued over-production of electrical engineers, I wrote an article[*] setting forth some facts in this connection. I hoped that its publication would lead others to similar action, resulting in a dissemination of knowledge concerning the opportunities in electrical engineering and a discussion of the relative advantages of the different engineering professions. The hope has been partially realized, and at least two long and praiseworthy contributions have been made by Mr. Jas. A. Cahoon,[†] who seems to see the situation largely from my own standpoint, and by Mr. A. A. Atkinson [‡], who argues the opposite side of the question. Among other statements made by the latter writer is the following: "The time is rapidly approaching when every central-station lighting and power plant, and every form of electrical business, will have their consulting and installing engineer.'' Such a statement, it seems to me, misleads the public, for no more than each steam or water-power installation, does each electrical installation necessitate a consulting engineer. The electrical manufacturing business is daily tending to the production of more simple apparatus, which may be operated by those who are ignorant of electrical laws; consequently there is less and less call for the highly-educated theoretical man in the more usual practical applications of electricity.

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[*] "The Advisability of Becoming an Electrical Engineer," *Electrical World*, April 14, 1894.

[†] "Training of the Electrical Engineer," *Electric Power*, January and February, 1895.

[‡] "Opportunities of Electrical Engineering," *Electricity*, April 24 and May 1, 1895.

Referring to my previous article, in which I showed that over twelve hundred young men are annually graduated as electrical engineers, Mr. Atkinson says: ''I know personally that, in one or two institutions whose catalogues are quoted by Mr. Floy to show the great number of students in electrical engineering, at least six or eight times as many are at the same time registered in the law departments alone, to say nothing of medicine and other professional departments.'' Even supposing this were true in all the institutions to which I referred, what strength is there in such an argument? It would be just as sensible to say that because there are a hundred times as many bricklayers in the country as there are electricians, therefore the demand for electricians is not met, and will not be, until bricklayers and electricians are numerically equal. We are concerned, not with the ratio of electricians to other professional men, but with the ratio of electricians to the number of positions available.

Mr. Atkinson says that the fact that a young man cannot get more than $40 or $60 a month in the electrical field is not a good reason for advising him to ''stay on the farm, or in the shop, or in the store, at $25 or $30 a month.'' If it were a fact that the young man who earns $25 or $30 on the farm or in the store could get $40 or $60 in the electrical business, we should all of us recommend him to change his vocation; but experience proves that to-day the average young man—I am not speaking of exceptional cases—will find, on entering the electrical business, that, instead of getting $25 or $30 per month, if that was his salary, he will more likely receive but $18 or $20. Any one acquainted with the salaries received by young men in the electrical business will bear out this statement.

While I can appreciate the situation of a father who, with a lot of boys ''coming along,'' finds it an extremely difficult matter, in these days of keen competition, to aid them in the selection of a business career which holds out promise of success, it is neither just to one's self or fair to the boys to decide that they shall become electricians simply because public opinion believes that in this line of employment are to be found golden opportunities for securing fame and wealth easily and quickly.

It would be surprising to those who have not had the opportunity to learn to hear fathers and mothers give the reasons why their sons have entered upon the life of an electrical engineer. In many cases I have found that, because a boy showed enough interest and ingenuity to put an electric call bell in his home, it was considered that he had a "calling" to the life of an electrician, the fact being overlooked that the same boy had evinced an equal or greater interest in carpentry, stamp-collecting, or base ball, for any one of which he was better fitted.

The old definition of electricity, "an unknown substance acting in an unknown way," has been discarded. To-day as much is known of electricity and its law of action as is known of gravitation or the power of steam, and any one who has a fair amount of intelligence and is willing to exert the requisite energy may learn its *modus operandi.* Thus, while we can say with the editor of the New York *Sun:* "There always has been, and there always will be, a good chance of success in the world for any young man who is faithful, industrious, patient, earnest, and true," yet these points must be particularly emphasized, if the young man is to succeed in electrical engineering.

While it may be argued from an examination of college records that to-day a large number of men are preparing themselves, as thoroughly as possible, by long and expensive collegiate courses, for expected openings in electrical engineering, many of them, nevertheless, have entered upon these courses of study for no other reason than that they share the erroneous opinion that handsome incomes and glowing fame are sure to reward all those who secure electrical positions. The truth is that, in the majority of cases, these positions are no more attractive financially than a thousand opportunities in other and longer-established lines of business.

Feeling sure of the over-production of electrical engineers, and in order to secure some facts as a verification of my convictions, I sent two hundred and sixty personal letters to the present year's graduates in electrical, mechanical, and civil engineering, from Cornell and Lehigh Universities and the Massachusetts Institute of Technology. The letters were sent in the latter half of September. My idea was to secure statements which would show comparatively the number of positions secured by recent graduates in electrical, mechanical, and civil engineering courses, to ascertain whether influence was necessary to secure positions, and, finally, to determine the salaries paid in these positions.

While statistics on these points might not prove anything, they would be a strong indication of probabilities. Of course, it would be more interesting, and possibly more valuable, to have these questions answered by men who graduated from college ten or fifteen years ago, and are well established in the line of work in which they will probably spend the remainder of their lives; but the impossibility of securing such information will be recognized, as men farther advanced in years have much more hesitancy about informing others as to their salaries and occupations.

The letter stated, in brief, that I desired to secure statements from recent graduates in reply to the following questions, the answers to which would be considered confidential:

1. Have you secured a position in the line of engineering since graduation?
2. Was this position secured through any relative?
3. Was this position secured through the influence of friends?
4. Of what does the work you are doing consist?
5. How many hours per day are you employed?
6. What salary do you earn per week?

The replies received were most interesting, courteous, and complete. They gave one an opportunity of becoming acquainted with, and an insight into, the character of some of America's recent and representative graduates in engineering, and the letters would prove valuable and instructive food for consideration by college professors. For example, the letters written by the graduates of one college were particularly noticeable as indicating their authors' lack of training in the use of good English. A number of the letters would make very interesting and helpful reading for young men about to enter the practical life of an electrical engineer. With the consent of the writers, I print extracts from three letters received from graduates in electrical engineering.

"I have made application by letter to about one hundred of the leading manufacturing and railway companies, consulting and contracting engineers, etc. Although more than one-half the letters sent have received kind attention and have been acknowledged, yet, from statements such as this: 'Our engineering force is now filled and more so,' I cannot but think that most of the positions secured must have been created through the influence of relatives or friends."

"After graduation, I wrote a number of letters applying for a position, but received discouraging replies. In these letters I mentioned nothing of shorthand and German. What I wanted was a start in engineering work; this is very difficult, as I know from my own case. I then wrote two more letters, in which, among other things, I mentioned my knowledge of shorthand and German, and also stated that I had had some experience in business. Both of these letters brought answers asking an interview. As a result, I have my present position. I believe

RESULTS OF INQUIRIES AMONG RECENT GRADUATES OF TECHNICAL INSTITUTIONS.

	CORNELL UNIVERSITY.			MASS. INST. OF TECHNOLOGY.		
	Electrical.	Mechanical.	Civil.	Electrical.	Mechanical.	Civil.
Letters sent	35	30	25	46	24	20
Replies received in per cents	31.4	34.3	48	69.5	33⅓	50
Of the writers heard from the following: Have Secured employment . . . per cent.	63.6	66.6	91.7	78.1	62.5	90
Secured employment in the line of work for which they studied . . . per cent.	45.4	66.6	91.7	65.6	62.5	90
Secured employment through influence of relatives. "	18.1	0	16.6	20	40	0
Secured employment through influence of friends... "	0	33.3	25	24	40	77.7
Average working day	8 hr. 42 min.	8 hr. 30 min.	8 hr. 15 min.	8 hr. 48 min.	9 hr. 22 min.	8 hr. 34 min.
Average pay per week	$9.70	$15.31	$13.65	$11.31	$14.12	$13.81
Average rate paid per hour on basis of 5½ working days per week	20.2 cts.	32.7 cts.	30.0 cts.	23.3 cts.	27.4 cts.	29.1 cts.

	LEHIGH UNIVERSITY.			TOTAL RESULTS.		
	Electrical.	Mechanical.	Civil.	Electrical.	Mechanical.	Civil.
Letters sent	27	17	36	108	71	81
Replies received in per cents	33.3	47.0	47.2	48.1	39.4	48.1
Of the writers heard from the following: Have secured employment . . . per cent.	100	100	82.2	78.8	75.0	71.8
Secured employment in line of work for which they studied . . . per cent.	88.8	87.5	82.3	65.3	71.4	87.1
Secured employment through influence of relatives. "	44.4	12.5	11.7	21.1	10.7	11.1
Secured employment through influence of friends.. "	22.2	37.5	23.5	15.3	32.1	35.8
Average working day	9 hr. 12 min.	9 hr. 15 min.	8 hr. 34 min.	8 hr. 54 min.	8 hr. 56 min.	8 hr. 27 min.
Average pay per week	$10.64	$10.75	$12.69	$10.70	$13.52	$13.27
Average rate paid per hour on basis of 5½ working days per week	21.0 cts.	21.1 cts.	26.8 cts.	21.8 cts.	27.4 cts.	28.5 cts.

that technical graduates could more easily obtain positions, if they had something else to recommend them, in addition to their engineering education. Perhaps I would not have a position now, if it were not for my other acquirements."

The following is written by a young man on the Pacific coast, and states his own ideas of the conditions there :

"The situation of a young electrical engineer on this coast is decidedly different from that of one in the east. Although an enormous amount of installation work of a high character is now being done here, it is entirely in the hands of the two great manufacturing concerns in the east. Naturally they send out their own men to equip plants. Moreover, with one exception, there are no manufacturers of commercial dynamo-electric machinery on this coast."

Following are the tabulated and averaged results of the replies received. There is a table for the graduates from each college, and also a table of the total. In making up these tables, I have tried to be fair and strictly impartial,—not a difficult task, as the replies were usually direct and to the point ; in only one instance was there a refusal to inform me as to salary.

Considering only the table of total results, which may be taken as a fair indication of the condition of the recent graduates in electrical engineering, it will be found that, while a greater per cent. of the graduates in electrical engineering secure employment, as compared with the other graduates, yet the fewest, relatively, secure employment in the line of work for which they had studied,—that is, in order to get employment, they had to take positions in which their electrical knowledge did not count. It will furthermore be noticed that almost twice as many men secure employment in electrical engineering through the influence of their relatives as in mechanical or civil engineering, while about half as many obtain positions through their friends as in the other two professions.

The working day averages about the same number of hours in each profession. Assuming five and one-half working days per week, it will be seen that the electrical graduate receives over twenty per cent. less per hour than the mechanical graduate, and twenty-three per cent. less than the civil graduate, who is the best paid of all.

THE LOCATION AND CONSTRUCTION OF DAMS.

By J. B. Johnson.

THE demand for artificially-raised water storage is rapidly increasing in all parts of the world. For irrigation, for power, and for domestic uses, unfailing supplies of water at commanding elevations can usually be secured only by the building of high dams across the outlets of great natural basins. The rapid multiplication of these enterprises, and the occasional failure of such constructions, with their far-reaching and disastrous results, give to this class of engineering works a perennial interest. In this article the present state of the science and art of dam-construction will be reviewed, with some suggestions of further improvements, and a few illustrations both of successful and of unsuccessful works of this class.

The conditions to be fulfilled by a dam are imperviousness and stability. It must intercept all flow, either through, under, or around it, and it must neither be overturned by the hydrostatic pressure, or washed away by the overflowing water, or undermined by the overfall or by seepage. At the same time it must be so designed as to pass the greatest floods, and to deliver the service-water as required.

Imperviousness in earthen dams is attained by means of a centrally-placed wall of masonry or of clay puddle, preferably the former, as shown in Fig. 1. To make a rubble masonry wall water-tight is a difficult task. It requires a character of workmanship entirely beyond the standard of the ordinary stone-mason. It means a wall without any openings whatever. To build such a wall demands the constant exercise of the scientific imagination. As a rule, this faculty is not highly developed in the modern stone mason. He must constantly foresee the opportunity for openings, and provide against them. Both the stone and the cement mortar used are practically impervious, and yet the ordinary rubble wall will leak like a sieve. The slushing of joints should not be allowed. The stones should have no hollow spaces on their lower sides. All joints and spaces between the large stones of a course should be entirely filled with mortar flush with the surface of the course, and then smaller stones and spalls should be pressed into this mass of mortar. Such work should not be let by contract, and it should be thoroughly supervised and inspected. Thickness of wall is no insurance of imperviousness. A thin masonry core is preferable, since then more care is sure to be

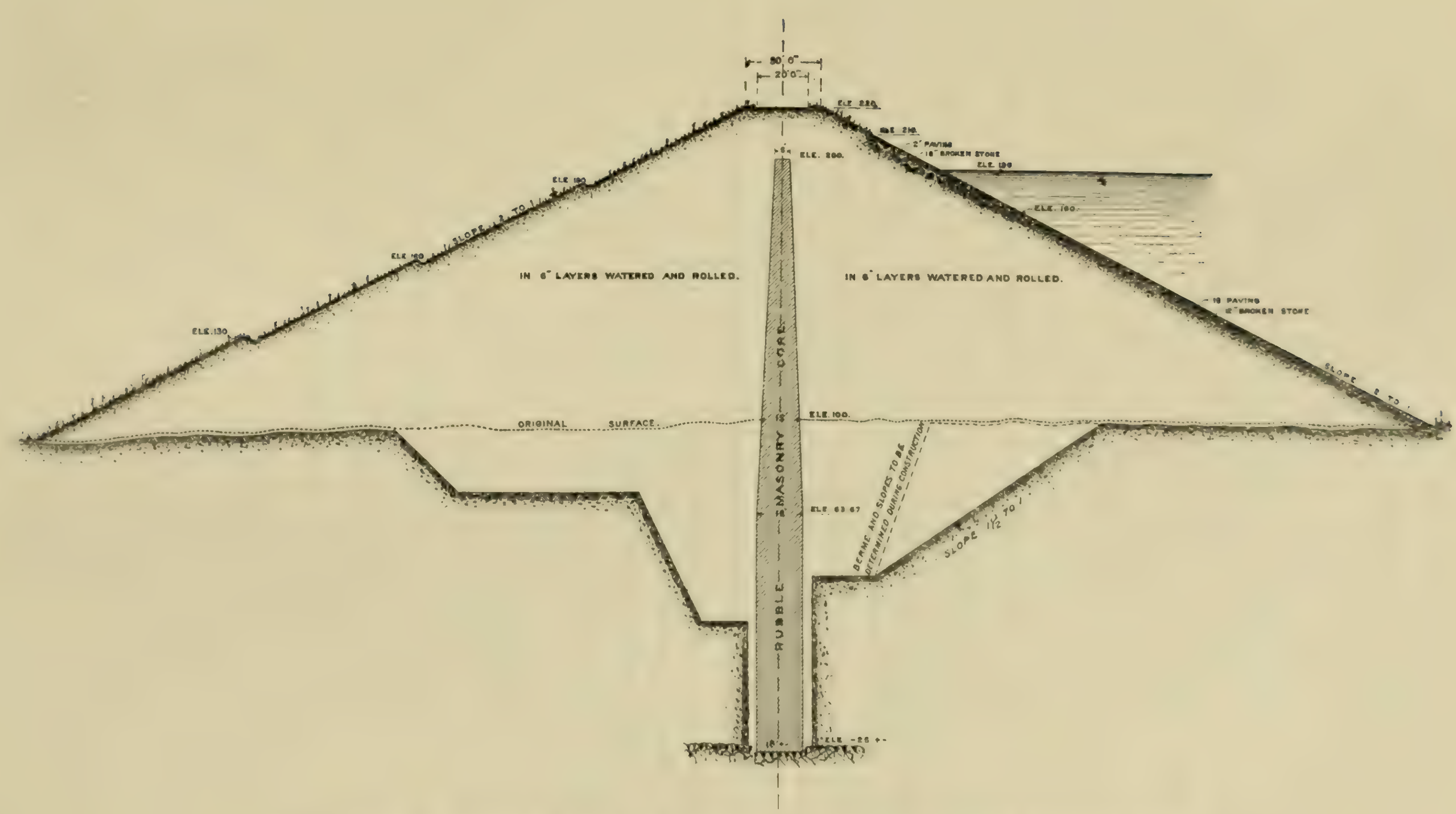


FIG. I.—EARTH PORTION OF THE NEW CROTON DAM, SHOWING RUBBLE MASONRY CORE.

given to secure absolute solidity. A surface coating of portland cement mortar, washed with neat cement whitewash, well brushed on, would add additional security. Recently the core has been made of thin iron plates, which are coated with asphalt and set vertically in the center of a thin wall of concrete, this concrete and metal wall extending, as usual, below the natural surface to an impervious stratum below, and into the side hills to a like limit. With the present cheap price of iron, this is probably the best possible practice. The plates could simply lap a few inches on all edges, and need not be riveted. Plates one-sixth of an inch thick would serve for this purpose. This would cost about as much as six inches in thickness of masonry wall, and it would not require more than a foot or two of concrete on either side of it. Cracks in the masonry walls of the storage reservoirs of Paris have been repaired by strips of pure caoutchouc soldered upon the hot cement by means of a solution of rubber in benzine.

If a clay-puddle core is relied on, it should be mixed with gravel and the whole thoroughly moistened and mixed in a pug mill in order to solidify it and to make of it a perfectly uniform mixture. This should then be laid in six-inch layers and thoroughly rolled. If the clay could be obtained in a pulverized condition in a dry state, it might be spread in alternate courses with the gravel, and then thoroughly harrowed until completely mixed, after which the combined layer should be wet through and allowed to stand till it is in a condition to pack, when it should be effectually compacted with a heavy grooved roller. Here again the scientific imagination is taxed to foresee the possibility of openings and to provide against them. In such work plans and specifications are of little value compared to the work of the resident engineer and his inspectors. Too often the corporation relies upon the efficiency of the plans and specifications, prepared perhaps by an eminent engineer, and foolishly thinks to save a few dollars by reducing the force of inspectors or employing entirely incompetent men. This is like having a great general plan a campaign, and then engaging a few ignorant corporals to conduct the battle. We read, however, that Napoleon was always on the ground and did his own inspecting.

When the material of which the body of an earthen dam is composed seems well calculated to form an impervious embankment, the masonry or puddle core is entirely omitted. Then the whole bank is constructed with care, and an entirely satisfactory dam may result.

Imperviousness of masonry dams also requires the greatest care, however thick the masonry wall may be. An excellent precaution in this case is to clean out all the joints on the upper face of the dam, to a depth of some two inches, while they are still soft, and then, after the dam is completed, or before the water is allowed to come upon it, point these up carefully with a rich portland cement mortar, one to one of cement and sand, pressing or driving this firmly into all such superficial openings. This will give as nearly an impervious sheet on the up-stream face as it is possible to obtain with masonry, since such a mortar is practically impervious to water. Laboratory experiments made by the writer on cement mortar disks two inches thick show that such a mortar, well compacted, is quite impervious under one hundred feet head of water. Mr. James B. Francis showed by experiment that ordinary portland cement mortar of one part cement to two parts sand was quite pervious, and in time transmitted some nine-tenths of the hydrostatic pressure upon it. This would seem to indicate that all the mortar joints of a masonry dam are subject to a lifting action, as this mortar commonly has three parts of sand to one of cement. In a recent paper Mr. John D. Van Buren recommended that this lifting action should be assumed to obtain throughout the entire body of the masonry, thus reducing the weight of all the masonry by sixty-two pounds per cubic foot. This would necessitate a very much greater width of base and a corresponding greater cost. Doubtless in many of the masonry dams now built this hydrostatic lifting action does occur over a considerable part of the lower horizontal planes of the dam, on the up-stream side; but to assume that it obtains over the entire section on every course is certainly to lean excessively to the safety side in making the computations. The proper solution would seem to be to obtain as nearly an impervious up-stream face as possible, and then leave all the joints in the body of the wall more or less pervious, so that a hydrostatic pressure here would be impossible. This would be accomplished by the pointing up of the joints on the water side with rich mortar, as described above. Doubtless the tensile strength of the cement mortar joints is commonly called into action as a result of the buoyant effect of this transmitted pressure. In the case of the highest masonry dam yet built, and the first one having a profile designed in accordance with scientific principles,—the Furens dam on the upper waters of the Loire in France, built 1862–6,—perfect imperviousness and stability were attained. This dam is subjected to a maximum water pressure of 164 ft. head, the dam itself being 184 ft. high above its foundation. Although it was built of rubble masonry, of stones from 2 to 7 cu. ft., and mortar joints from ¾ to 1¼ in., and no extra precautions taken in pointing up the joints on the up-stream side, yet the work was done so carefully and under such skilful supervision that no seepage through or under it has occurred, and a trench dug at the outer toe remained quite dry for four months with the reservoir full of water. So much for skilful execution. On the other hand, it is not uncommon

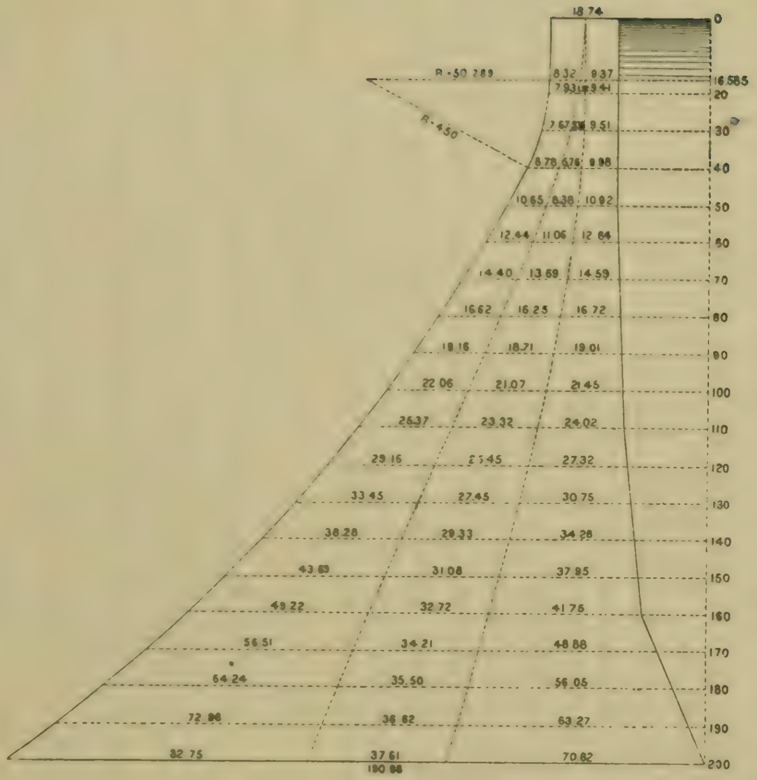


FIG. 2.—PROFILE FOR MASONRY DAM, 200 FEET HIGH.

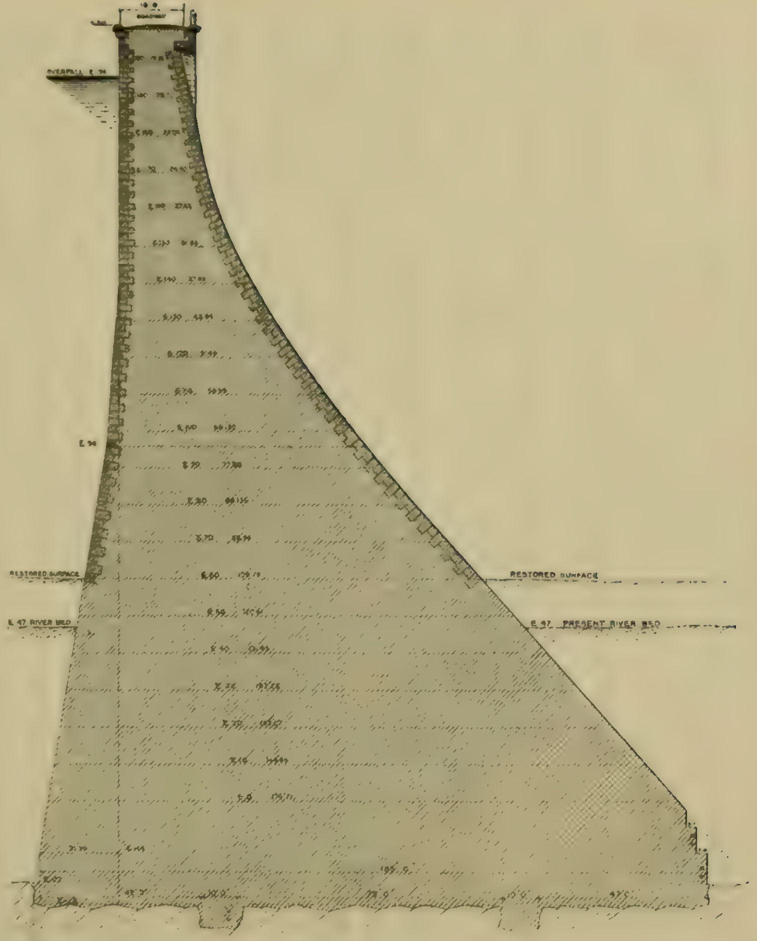


FIG. 3.—MASONRY PORTION NEW CROTON DAM.

in this country to see leaky reservoir walls, built of highly-dressed dimension stone, with ¼-in. joints. This very expensive masonry may argue skilful designing, but, if the execution be bad, no adequate return is obtained for the money expended. In general, however, the execution has been sufficient to insure both imperviousness and stability, for very few masonry dams leak badly, and many are absolutely tight. Out of fifty-five high masonry dams which have been built in this century only three have failed. One of these failures was due to a pile foundation ; one to wretched construction causing it to leak like a sieve, and giving the lifting action of the water pressure on all the joints ; and the third was the Bouzey dam failure, described later.

The slopes of earthen dams are so low, to prevent erosion, being usually about two horizontal to one vertical on each face, that there is no question of their stability, whatever their height. With masonry dams, however, the width is properly made the least which is consistent with stability. There is usually no danger of sliding outward. If founded on natural rock, it is set somewhat into the same, and is firmly attached to it by its cement bed. If resting on earth, it passes well below the surface, and hence is firmly imbedded against bodily lateral motion. The only question of stability, then, is that of overturning.

The first question is to decide whether or not to treat the dam as a solid mass. If the water does not find access to the horizontal joints, it may be so treated. This is commonly assumed to be the case. Since the best portland cement is now always used in these structures, there is no question of a masonry dam acting as one complete monolithic mass. As such, if the dam is straight, it resists the overturning action of the water by its dead weight alone. If resting on rock at the bottom, it is probable that the masonry is very firmly attached to it, so that the dam might really act as a beam protruding from the earth and laterally pressed or loaded ; and this may explain why some dams do not overturn, when it would seem, from the principles of statics, that they ought to. However, it would not be safe to assume any such action.

Treated as a monolithic mass, therefore, but one which cannot resist an upward tensile stress on any horizontal joint, it follows that the center of pressure on each course must fall inside the middle third of the thickness in every horizontal plane. For, treated as one solid mass, if the center of pressure were outside of these limits, it may be shown by graphic analysis that there would be a tensile stress on the water side of the joint. Since it is desirable to make the thickness as small as possible to satisfy this requirement, it is common to let the line of resultant thrust fall just one-third the thickness from the outer (downstream) face of the dam.

It is a remarkable fact that previous to 1860 no masonry dam was ever built with any correct theoretical analysis for dimensioning its thickness. MM. Sazilly and Delocre of France made such analyses in 1853 and 1858 respectively, and, based on the true theory, then first made known, the Furens dam was built. Thus both the theory and the practice of masonry dam construction jumped to practical perfection in the first application of the theory, and the Furens dam still stands unsurpassed in economy of section, in height, in imperviousness, and in stability, for it is apparently able to stand for all time. The new Croton dam, now building, will exceed it in height, when completed, its height being 240 ft. above its rock foundation, and 150 ft. above the bed of the stream. The profile of Mr. Edward Wegmann, for a masonry dam 200 ft. high, is shown in Fig. 2, and that of the new Croton dam in Fig. 3.

Notwithstanding the fact that French engineers first put the building of masonry dams on a rational basis, they have sometimes violated these rules. Thus the Bouzey dam near Epinal, built in 1881 to a height of sixty-five feet above its foundations, had so slender a profile given to it that the line of pressure fell well outside the middle third. Soon after it was filled, it slipped bodily more than a foot on its foundations, and was badly cracked. It was repaired in 1889, but, although known to be dangerous, it was allowed to fill with water, and it failed by overturning on April 27, 1895, resulting in the loss of one hundred and fifty lives. Evidently water found its way into the horizontal joints on the up-stream side, where these joints were subjected to a considerable tensile stress, and this upward pressure of the water was sufficient to destroy all its moment of stability.

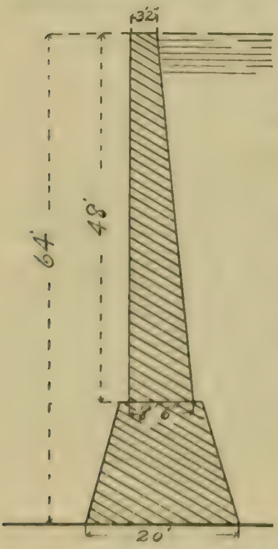
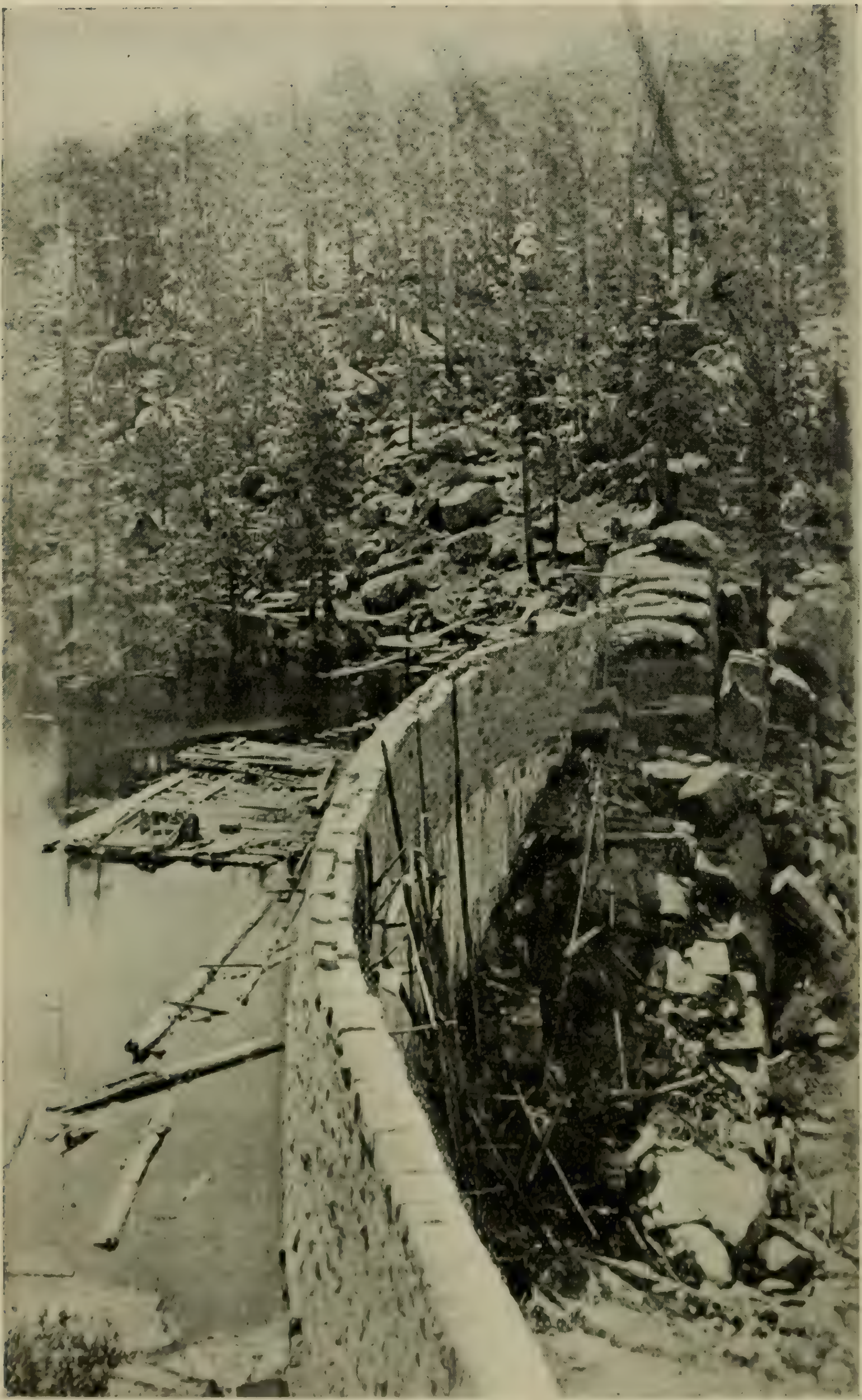


FIG. 4.—PROFILE BEAR VALLEY DAM.

In order to obtain stability at a less cost, masonry dams built in a deep, narrow defile or cañon, with substantial rock sides, are sometimes arched up-stream by giving them a circular form in plan. The determination of the reaction forces at the sides and bottom, in this case, and thence the stresses in the masonry, depends altogether on the deflection or movement of the dam from the water pressure against it, and on its rigidity vertically and horizontally. Since the bottom courses are rigidly attached to the foundation rock, they can, of necessity, offer no arch resistance, but, as the upper courses are deflected downstream, being arched up-stream, the horizontal arch comes into action to resist such a movement. Evidently this arch action will be greatest at the top of the dam, where the water pressure reduces to zero, since the outward movement here is the greatest. It will also be greater as the thickness of the dam is less. That a thin dam so constructed does receive a sufficient support from the arch action to sustain it is evidenced by the profile of the Bear Valley dam (Fig. 4), which has stood since 1884. Its length at top is 270 ft., and its radius of curvature is 355 ft. At the center the deviation of the dam from a straight line is about 27 ft., this being the versed sine of the subtended angle. The extreme attenuation of this section, being only 38 in. in thickness at top and 102 in. at a point 48 ft. below, has no equal; but it was forced upon the engineer as a matter of economy. It was built for the purpose of developing the country by means of irrigation, and all the cement and other supplies had to be hauled by teams one hundred miles over two mountain ranges and across a desert. Under such circumstances some risk can be allowed. Since the increase in volume, from increased length, of a curved dam over a straight one is never over five per cent. in any practical case; and since either the volume of masonry may be greatly reduced for a given factor of

SITE OF NEW CROTON DAM; RIVER DIVERTED; SIDE HILL EXCAVATED; BEGINNING OF DEEP EXCAVATION IN BOTTOM OF VALLEY.

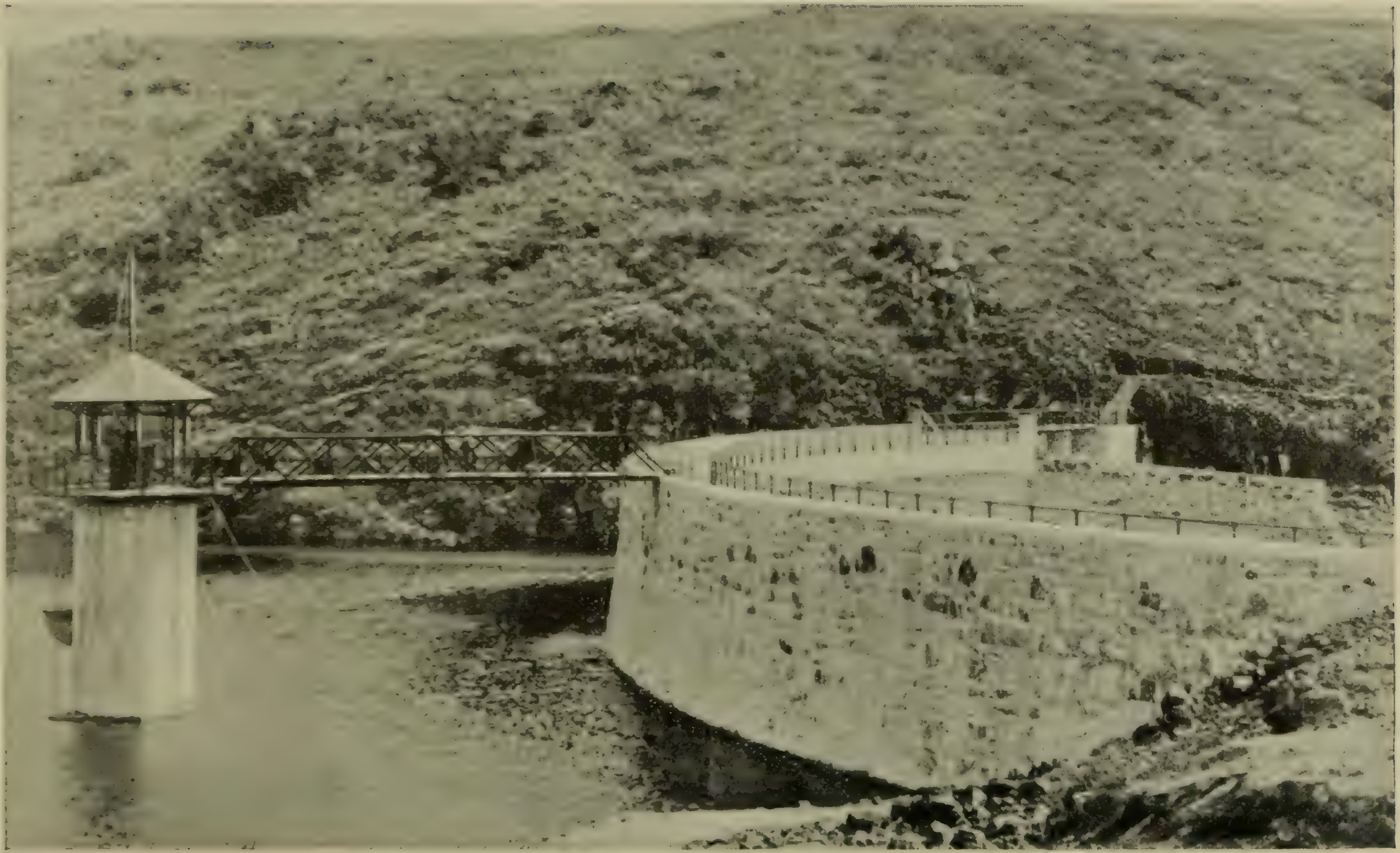


BEAR VALLEY ARCHED MASONRY DAM, CALIFORNIA.

safety, or for the same volume of masonry a much greater factor of safety may be had ; and, furthermore, since a curved dam presents an appearance of having greater strength and is more beautiful, so satisfying at once the æsthetic taste and sense of security,—there would seem to be every reason for making all masonry dams occupying narrow valleys with rocky sides of the curved form. The most noted example of such a combined gravity and arch profile is that of the Sweetwater dam in southern California. The dimensions of this dam are as follows : thickness at base, 46 ft. ; thickness at top, 12 ft. ; height, 90 ft. ; radius of arch at top, 222 ft. The upper face batter is 1 to 6 to within 6 ft. of the top, thence vertical ; on the lower face it is 1 to 3 for 28 ft. ; 1 to 4 for 32 ft. ; thence 1 to 6 to the coping. The line of pressure would fall at the center of the outer third for water up to the top of the dam proper, if it were straight, but in January, 1895, a flood discharge ten times the maximum provided for in designing the waste weir caused the water to rise twenty-two inches over the parapet wall and five feet above the highest level for which the dam was designed. If the dam had not been curved, it would doubtless have gone out at this time. The dam was subjected to this cataract action for a period of forty hours, but was in no wise injured by it. A trench was excavated by the overflow beyond the outer toe of the dam, and some of the conduit pipes were washed out, but the dam itself was entirely uninjured. Precautions have since been taken to increase the wasteway, and also to lay additional outlet pipes in a lateral tunnel around one end of the dam to prevent a repetition of the occurrence.

The objects sought in the location of a dam are : (1) the storage of the greatest quantity of water at the least cost of dam, ground, and conduit to bring the water to its destination ; (2) favorable material to serve for the foundation of the dam ; (3) a satisfactory means of passing the flood waters.

To satisfy the first requirement a large natural basin is sought, surrounded by hills of sufficient height, and with a narrow outlet with rock sides and bottom across which to place a dam. The storage capacity is readily computed from a good contour survey of the basin, which, if made by the transit and stadia method, will be found to cost very little. The character of the foundation is determined by sinking wells, or pits, to the natural rock in a line along the line of the proposed dam. Boring should not be relied on for this investigation. The sources of supply for suitable clay and gravel, if the dam is to be an earthen one, and for rock and sand, if it is to be of masonry, are also carefully determined, and the cost of transporting cement and other supplies estimated. From all such definite information the financial problem may be worked out. The second and third conditions are questions of engi-



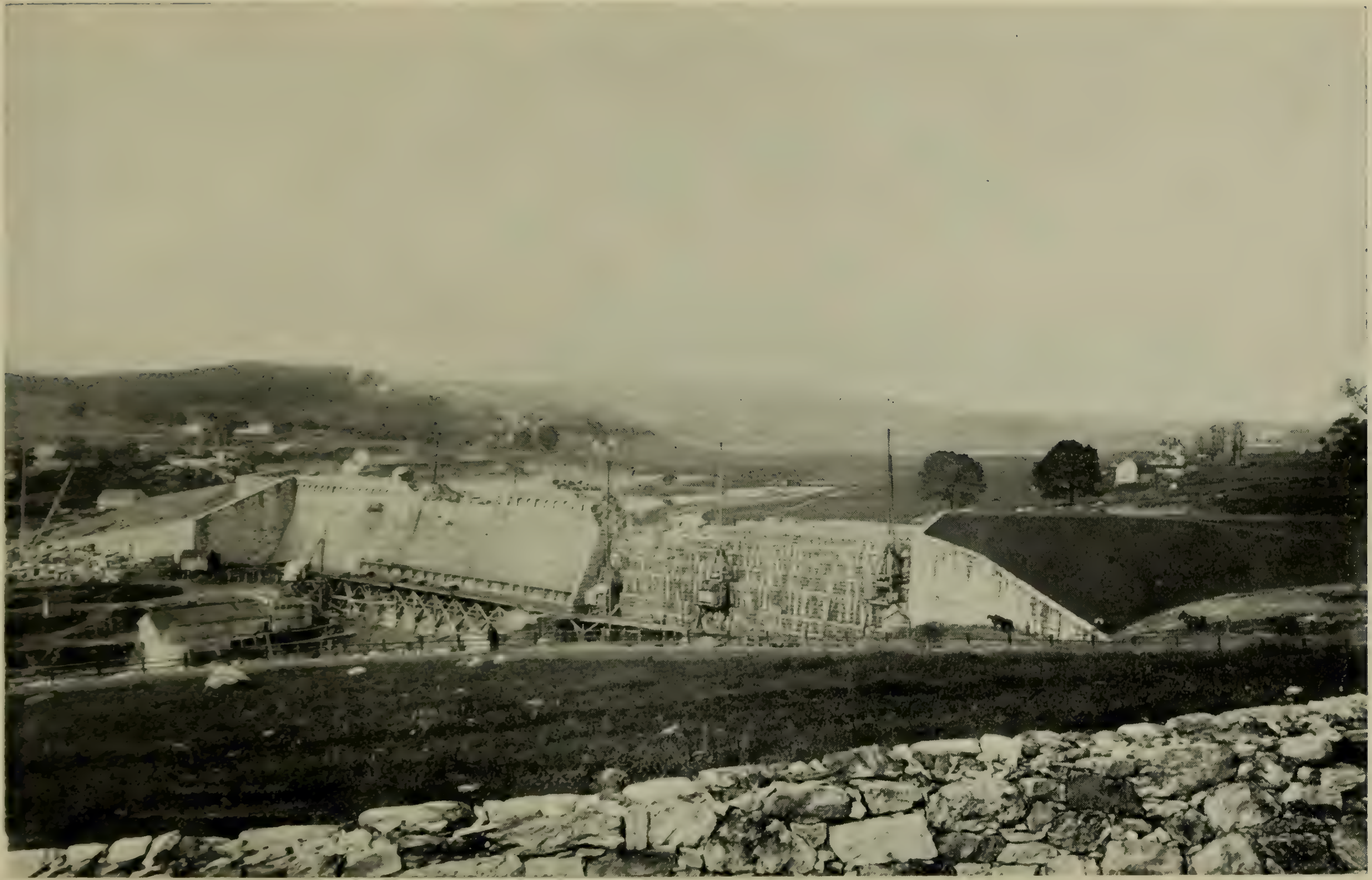
SWEETWATER ARCHED MASONRY DAM, SOUTHERN CALIFORNIA.

neering, and, if a satisfactory solution is found, the project may be allowed to proceed to its execution.

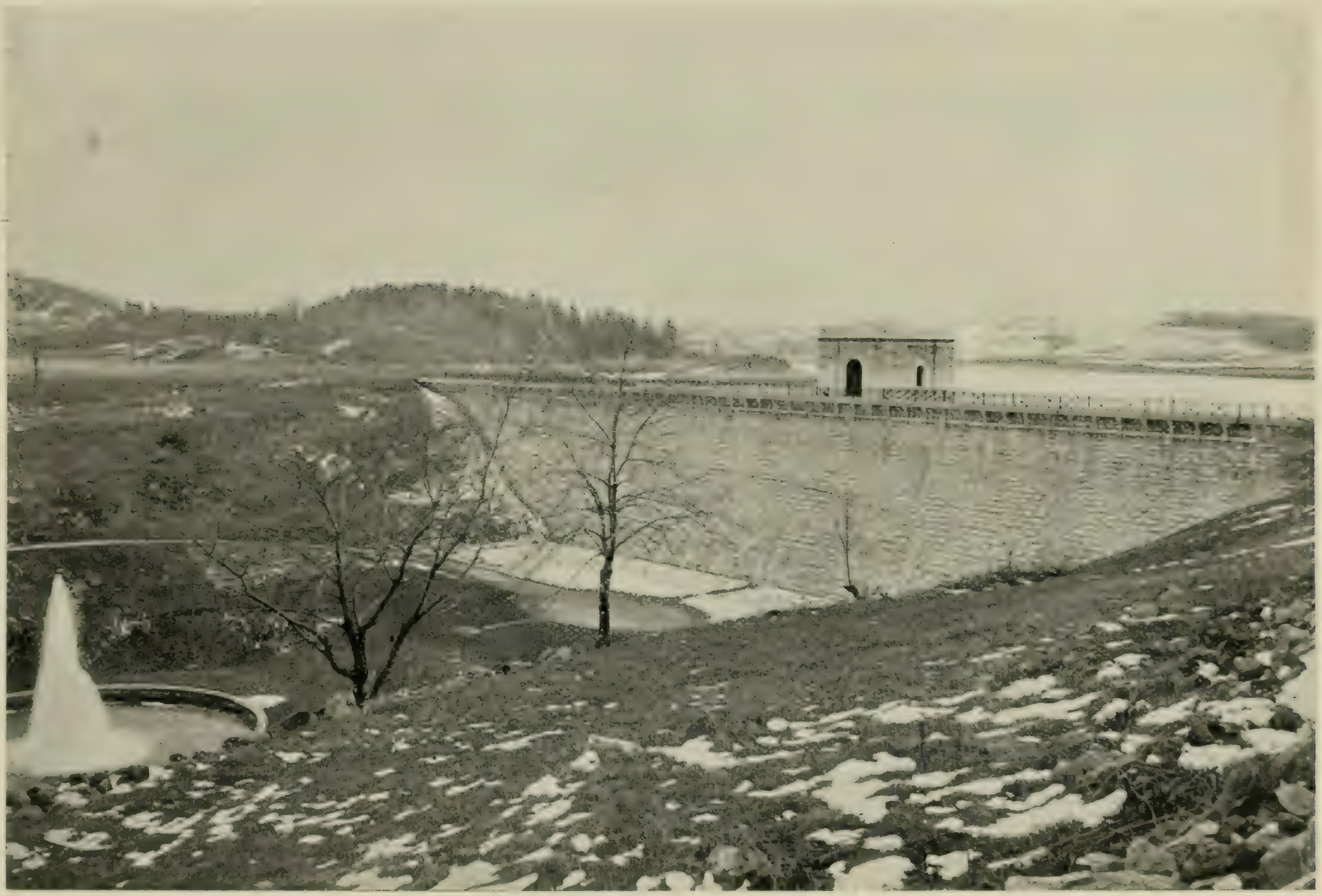
If a suitable foundation, sufficiently impervious and firm to carry the proposed structure, cannot be found, the site must be condemned without further question. An example of what may happen to a masonry dam or reservoir wall which has been placed on an insecure foundation was lately given in the case of one of the division walls between two of the settling basins of the new St. Louis waterworks, after a washout had occurred. These walls are 8 ft. wide and 15 ft. high, and rested on a bed of concrete 15 ft. wide and 4 ft. thick. The sub-foundation is a river silt deposit, being a varied mixture of sand and clay. Reliance was placed on the imperviousness of the bottom linings of these basins, which consisted of 18 in. of well-rammed clay puddle, and 6 in. of cement concrete, laid in blocks 7 ft. square, with asphaltum joints. The rupture occurred suddenly, on October 12, 1895, one basin being full and the other entirely empty, the groundwater lifting bodily an area of bottom about 100 ft. square. The fact that the stone wall stood unsupported, without visible depression, on a span of 61 ft., argues well for the character of the masonry. The wash-out must have been caused by some porosity of the bottom linings of the basins.

A satisfactory means of passing the flood waters is not always easily found. If it is desired to make the dam of earth, it becomes absolutely necessary to pass all flood discharge around and not over the dam. Inadequacy of such flood passages has been the direct cause of nearly all failures of earthen dams, that of the South Fork dam, above Johnstown, in 1889, being the most notable in recent years. While the maximum flood discharge can never be predicted, engineers have certain well-defined means of estimating such matters, based on known climatic conditions of the region and a knowledge of the topographical features of the drainage basin in question, so that, by applying a reasonable factor of safety, for extraordinary floods, the outlet may be made large enough to insure the safety of the structure. Furthermore, they are able to compute almost exactly what the discharging capacity of any given outlet is, so that no part of the solution of this problem need be a matter of guesswork. In the case of the South Fork dam, although the outlet weir was entirely too short for the purpose, the outlet channel below this weir was so reduced in size as to limit its capacity to only fifty per cent. of that of the weir. This was due to simple ignorance of the laws of flowing water, but, as no civil engineer had anything to do with the work, the failure reflects no discredit on the profession.

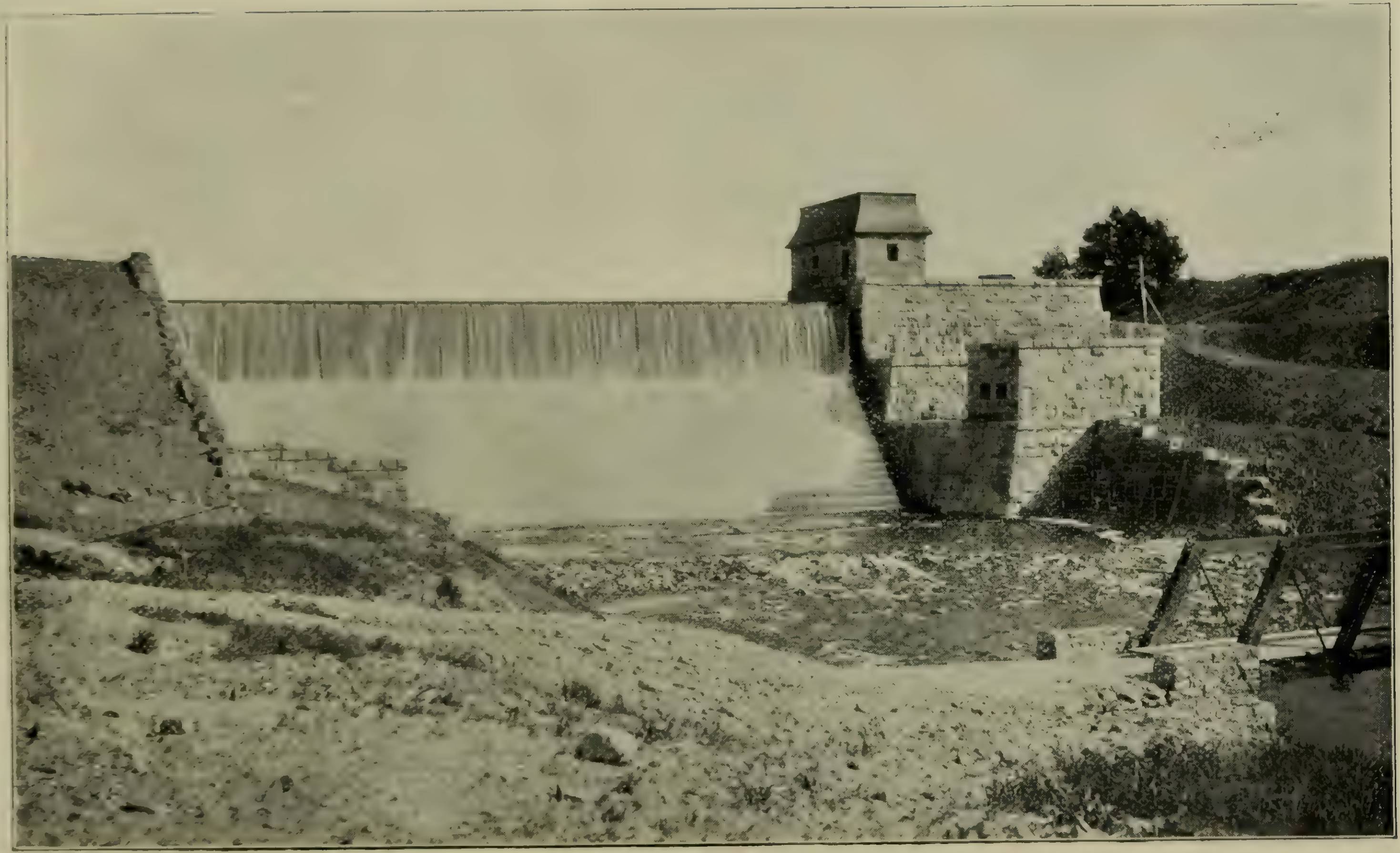
If the area and topography of the drainage basin is known, and if



TITICUS DAM (CROTON SYSTEM) ALMOST COMPLETED.—DOWN-STREAM FACE.



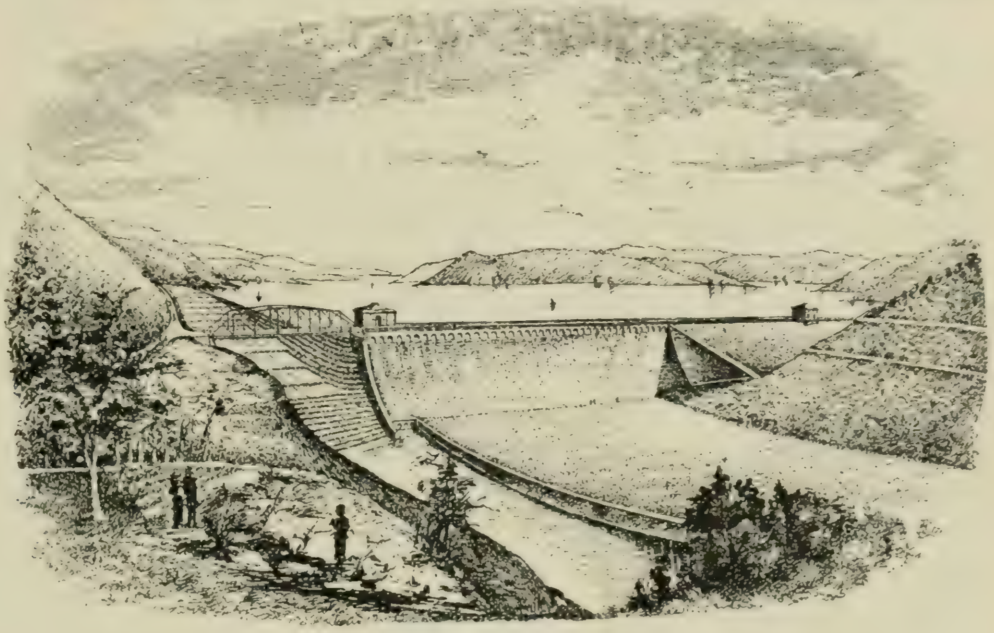
EAST BRANCH CROTON RESERVOIR, SODOM CENTER, N. Y.



THE DUNNING'S STEPPED MASONRY DAM, PENNSYLVANIA.

the maximum rate and continuance of rainfall can be approximated, or if the maximum high water marks reached by the stream before it was dammed can be found, then the maximum rate of discharge can be arrived at very closely, and the length of waste way determined. In a new country these data cannot be had, and the engineer must make such assumptions as seem to him safe. How dangerous it is to proceed without this knowledge is shown by the case of the Sweetwater dam, before described, where the flood of January, 1895, was ten times as great as the assumed maximum. In such cases it is necessary to so construct the dam as to allow the flood to flow over it for a short period in an emergency, without endangering it.

The wasteway is not simply the overflow weir, but the entire lateral channel leading from this weir; and care must be taken to see that the capacity of this channel is always greater than that of the weir, so that the weir is the controlling or governing element. Such a properly-designed lateral channel is arranged for in the new Croton dam plans. This channel is stepped for the purpose of avoiding too high a velocity of water, on the one hand, and too great a vertical fall, on the other.



LATERAL CHANNEL, NEW CROTON DAM.

Sometimes the wastage can be across a dividing ridge into a neighboring drainage basin, and sometimes it is through tunnels in the solid rock around one or both sides of the dam. Waste gates and scouring sluices may also be placed in the body of the dam itself. Especially is this done in the case of irrigation dams and diversion weirs. In the case of the lower Nile the flow is all passed through such sluices, the height to which the water is raised being only about 15 ft.

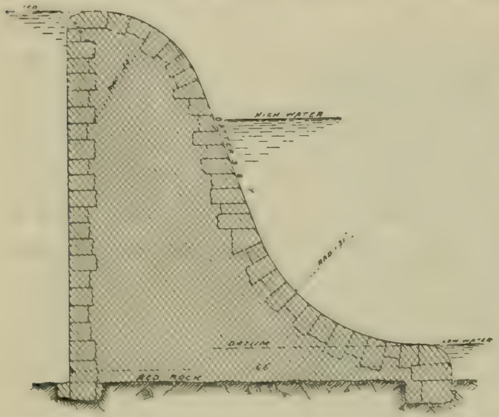


FIG. 5.—COLORADO RIVER DAM AT AUSTIN, TEXAS.

When the dam itself, in whole or in part, serves, as the waste weir, it must, of course, be built of masonry, and the weir and lower side must be built in the most substantial manner. It is customary to make these parts of large granite blocks, thoroughly bonded, and laid with best cement mortar with dressed joints. It is desirable, also, to make this lower side a plane of double curvature, as shown in Fig. 5, making the beds of the courses approximately normal to the surface at all points. This prevents any actual impact of the water against the surface, and discharges the flow horizontally from the outer toe of the dam. The masonry dam across the Mohawk river at Cohoes has recently been repaired by constructing a curved front of quarter-inch steel plates on a steel framework. These were backed by concrete. Many engineers prefer to make the lower face of an overflow dam a series of stone steps, thus destroying the acquired energy of the water at each step, and so preventing any violent action upon the masonry. For low overfalls this construction serves the purpose very well, as at the Dunning's dam, Pa.; but, for overfalls several feet in depth on the weir, these steps would have to be so very broad as to produce an extravagant width of profile.

While masonry and earthen dams are among the earliest kinds of engineering works, and while we have in this field as good a "hindsight" as in any other branch of engineering, yet the building of dams so as to insure security, economy, and permanency still demands the highest engineering ability. Our best engineers approach this problem with a feeling of grave responsibility, and they design and execute such works with the most conscientious and painstaking care and study. When so undertaken, and with a guarantee of sufficient means, these enterprises may be entered upon with a feeling of absolute certainty of permanent success, while in incompetent hands, or with insufficient funds, these structures are always liable to be a source of loss to their owners and of danger to the lives and property situated in the valleys below them.

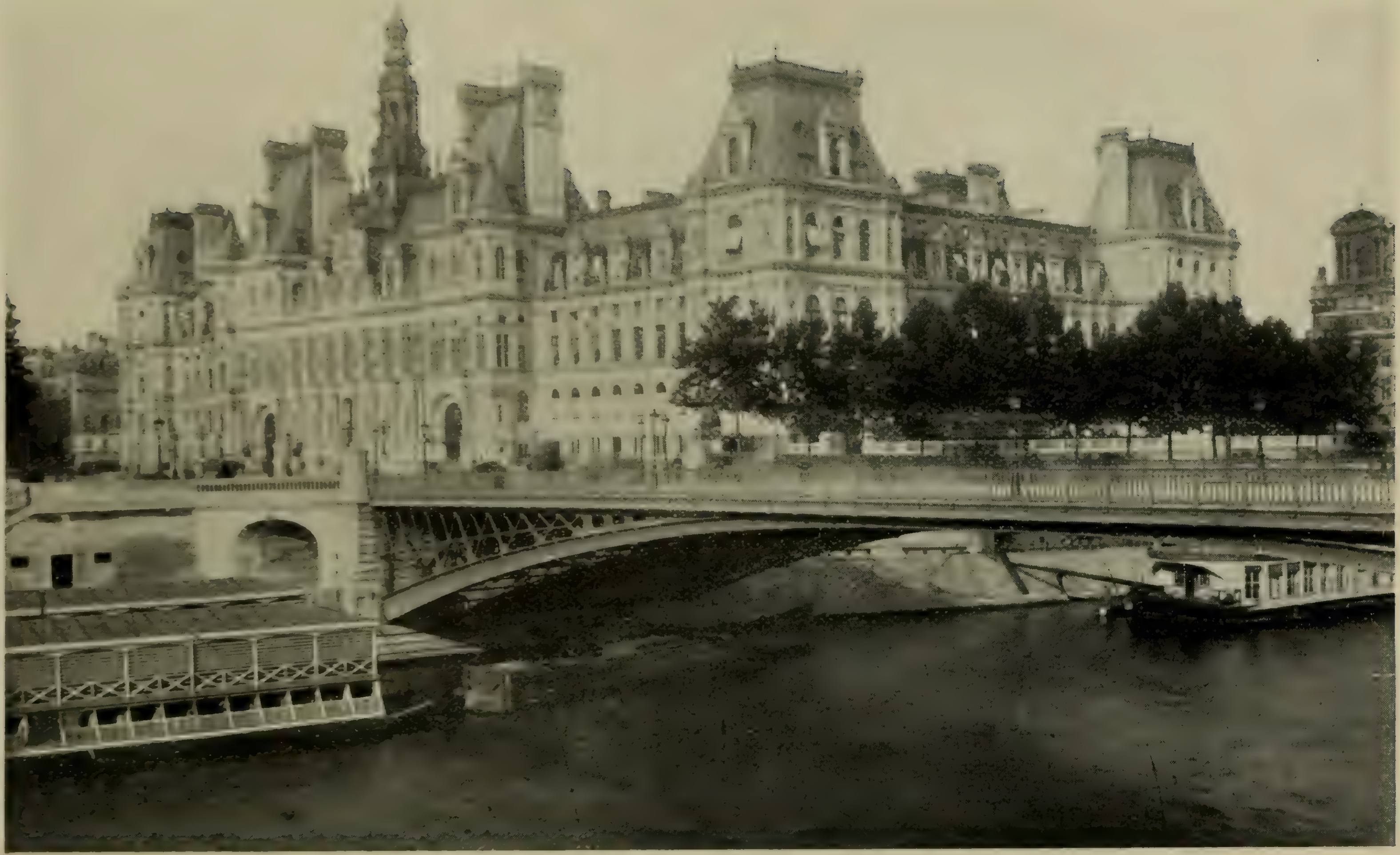
THE VALUE OF GOOD ARCHITECTURE IN CITIES.

By Barr Ferree.

FROM the obelisk in the Place de la Concorde one sees spread out before him, not only the most magnificent spectacle in Paris, but one of the grandest sights in Europe. To the north, stretching in almost endless perspective, is the beautiful avenue of the Champs Élysées, heavily wooded on each side with trees, and closed in the far distance by the Arc de Triomphe. To the left are the stately buildings of the Garde Meuble, with the façade of the Madeleine at the end of the Rue Royale between them. Far off, on the other side of the Seine, is the porticoed front of the Chambre des Députés, with many other noble buildings on the river. To the south are the gardens of the Tuileries, and beyond is the vast court of the Louvre, whose sumptuous architecture and great extent make it one of the most monumental buildings in the world. There is everything in the view to fascinate the beholder, and even to overpower him with the sense of man's ability to create beauty out of the work of his hand. Every part of this tremendous spectacle, if we except the river Seine, has been made by man for his own delectation and delight. And there is the union here of everything that could contribute to the architectural grandeur of the scene. This Place de la Concorde, in which we imagine ourselves standing, is magnificent in itself, with fountains and statues, ornamental balustrades and lamp-posts. The parks on either side, though almost in the heart of Paris, are of great extent, not only allowing ample scope for artistic treatment, but large enough to give each of the buildings around them a distinct individuality. And each is a masterpiece, each a work of art that we count, and always shall count, among the great achievements of architecture.

Paris is full of monumental buildings and artistically-planned spaces, though nowhere is the effect so surpassingly grand as between the Louvre and the Arc de Triomphe. The Opéra, the Palais Royal, the cathedral church of Notre Dame, the Palais du Luxembourg, the Hôtel de Ville, the Palais de Justice, and many other public buildings in this superbly-built capital are veritable object lessons in art, instructors of the people, sources of genuine joy and satisfaction to those who see them, monuments with a civic and educational force apart from their purely architectural interest.

This is the real value of artistic architecture in cities, though as



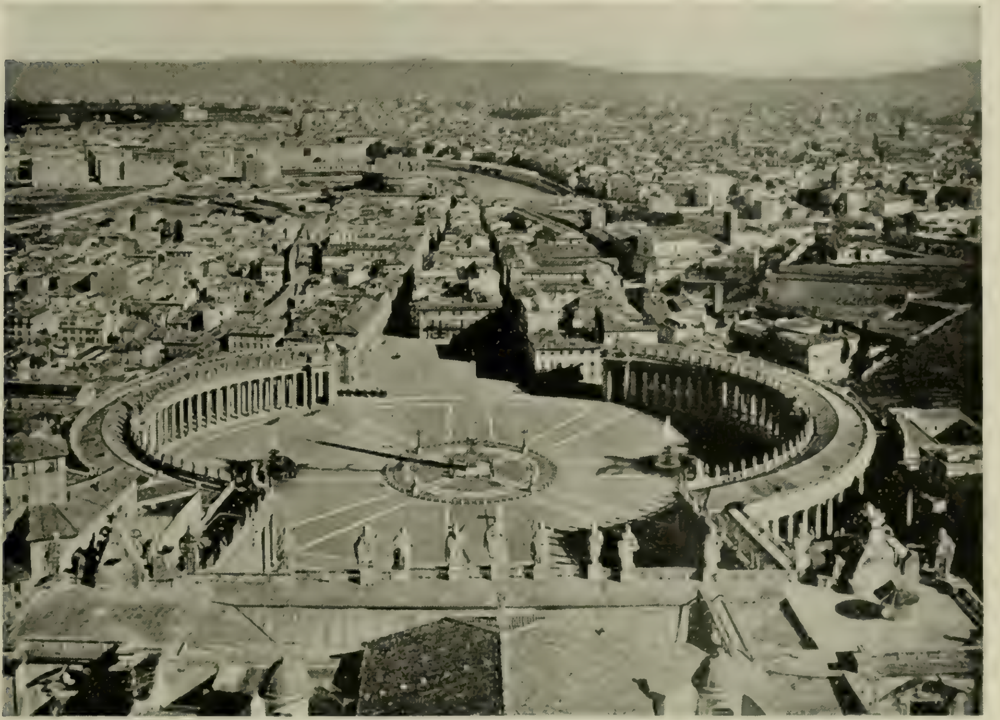
HOTEL DE VILLE, PARIS.

THE COURT OF THE LOUVRE, PARIS.

IN THE GARDENS AT VERSAILLES.

yet we scarce understand it so in our American communities. It is true that, of the thousands of strangers who flock to Paris every year, only a relatively small portion go especially for its monuments. But these monuments, by their art, their splendor, and their number, help, in a very material way, to make Paris the world-capital it is; for Paris without its monuments would be, not Paris at all, but a commonplace town in which there was nothing to see and perhaps not much to do!

Paris is the most conspicuous instance of a monumental city, magnificently planned and filled with great works of architecture; but there is not a capital of Europe that has not an abundance of splendid buildings. Venice has its Piazza di San Marco; Florence and Pisa have their cathedral groups; Rome has its Piazza di San Pietro, Piazza del Campidoglio, and Piazza del Popolo; Vienna its Ring Strasse; Dresden its Zwinger; Berlin its Königsplatz; Munich its Königsplatz; Moscow its Kremlin; London its Houses of Parliament and Westminster Abbey. It would be easy to extend the list, for to be complete it must include all those great buildings that make a European tour not only delightful, but a liberal education in itself. These examples, however, must suffice as instances where a single great building, or a group of buildings, alone or in connection with surroundings, form an artistic centre in their respective cities, and in


THE PIAZZA DI SAN PIETRO, ROME. FROM THE DOME OF ST. PETER'S.

OPERN & KÄRNTHNERRING, VIENNA.

ZWINGER GALLERIES, DRESDEN.

many instances rise to the height of the sublime, and in all teach impressive lessons of art and culture.

The education of the people is a problem that has confronted thinking men of all nations for centuries. That mankind has a natural tendency to sink, and that he must be dragged out of the depths towards which he naturally gravitates, appears to be an unquestioned sociological fact. Almost up to the present time the efforts of educators have been limited chiefly to mental discipline by books. But the tendency of education is rapidly changing. The introduction of technical schools for higher studies prepared the way for manual training for less advanced students. It has been borne in upon those who direct the educational systems of nations that there is an instruction by eye and by hand that may be as valuable as education by mind. And so art training has become an integral part of the common-school curriculum, though as yet it is not very well organized or properly systematized. But it has "arrived," as the French say, and, having come, it must bring with it permanent lessons of truth and beauty.

But modern life is too active for the art education of the people to be limited to that which they may gain within the confines of the school-room. It is not like the differential calculus, to be taken up at one brief period of existence and then cast aside forever save by specialists. The glory of art is its beauty and its permanency, which

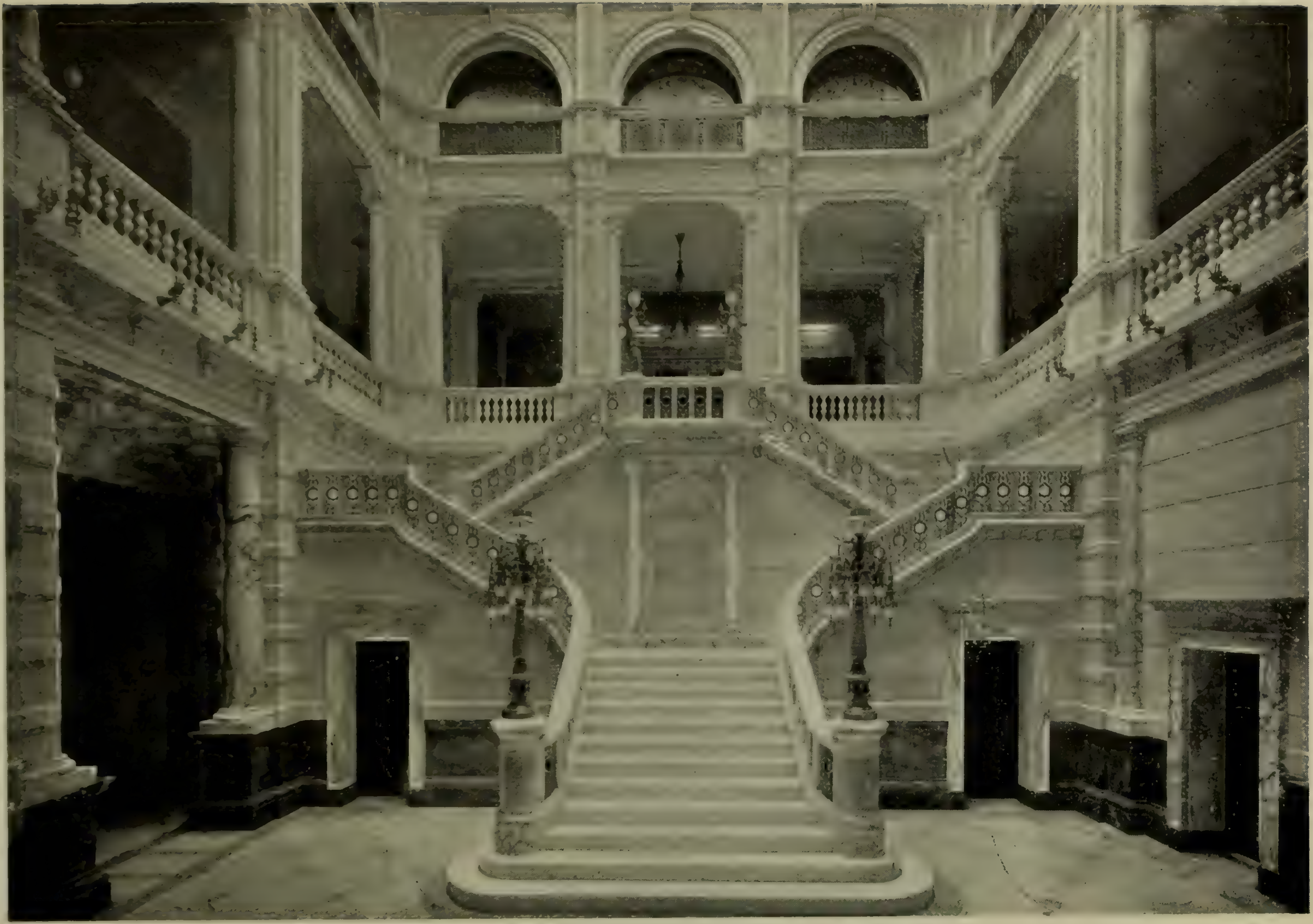
THE OLD PICTURE GALLERY AND BRIDGE, BERLIN.

lighten and brighten our lives at every moment; and the more abundantly we can surround the people with beautiful things, with fine parks and flowers, with magnificent buildings, with noble sculpture, yes, and cover our churches, our civic buildings, and the walls of our museums with inspiring pictures, the better it will be for our national welfare, the more firmly will our culture be strengthened, the broader will be our sympathies, the keener our appreciation of what is noble and good.

How much there is to be done in this direction every thoughtful American must be fully aware. Though our cities are numbered among the largest of the world; though our individual and national wealth surpasses that of any other country; though our national resources are boundless and our people renowned for a highly developed inventive faculty,—we have few monuments of art worthy of the name, few inspiring buildings that appeal to educated and uneducated eyes alike.

PLACE DE LA BOURSE, BORDEAUX.

Yet we can show some steps of progress. All our great cities have their parks and public gardens, in which each year brings a notable advance in landscape and floral art. And our wealthy men have cordially agreed upon the necessity for handsome residences for themselves in town and country, and ornamental architecture in this class of build-



INTERIOR COURT, METROPOLITAN BUILDING, NEW YORK.

ings has taken a good step forward. And we have done more than that; for our business corporations, great commercial companies, and large investors are spending vast sums of money in the erection of costly commercial buildings, hotels, and apartment houses in which an artistic effect is attempted, even though it be not always achieved.

This much we may credit ourselves with; yet how paltry and insignificant our achievements when compared with the splendid municipal art of Europe! True, the continental cities have the advantage of age over the American, but many notable buildings have been erected abroad in the same time that we have been taking our first wobbling footsteps in civic adornment. The transformation of modern Paris is sufficient answer to those who would plead the extreme youth and extraordinarily tender age of American communities as an excuse for their lack of artistic buildings.

METROPOLITAN CLUB, NEW YORK.

Of our national architecture the less said the better. It exists, it is true, to the defoulment of our cities and the debasement of our national intelligence; and, though these buildings are of stone and brick, and therefore lasting, it is some satisfaction to know that the voice of condemnation against them is swelling in volume each year. It is at least encouraging that the public at large feel there is "something the matter" with our government buildings, and recognize that here is a type of architecture to be shunned as we would shun a pestilential disease.

There is yet scarcely a hint of improvement in the buildings erected under the direction of our national government, and there certainly never will be while our government architecture is devised in the present extraordinary wholesale fashion; and those done by our municipal and State authorities are scarcely better. One of the latest buildings erected by the city of New York, the criminal court house, is quite as bad as anything turned out by the architectural mill of the treasury department at Washington. The two most costly public buildings in America, the capitol at Albany and the new public buildings in Philadelphia, have nothing to commend them but their cost and their size, and a certain gaudiness of interior decoration that cannot make up for the lack of real art. On the other hand some extremely beautiful small buildings for municipal use have been built in Boston by Mr. E. M. Wheelwright, and a few State governments, notably those of Rhode Island, Minnesota, and the State of Washington, have instituted architectural competitions for new capitols, which, although the system is a bad one, have resulted in designs that show a decided advance over the capitols of the average type.

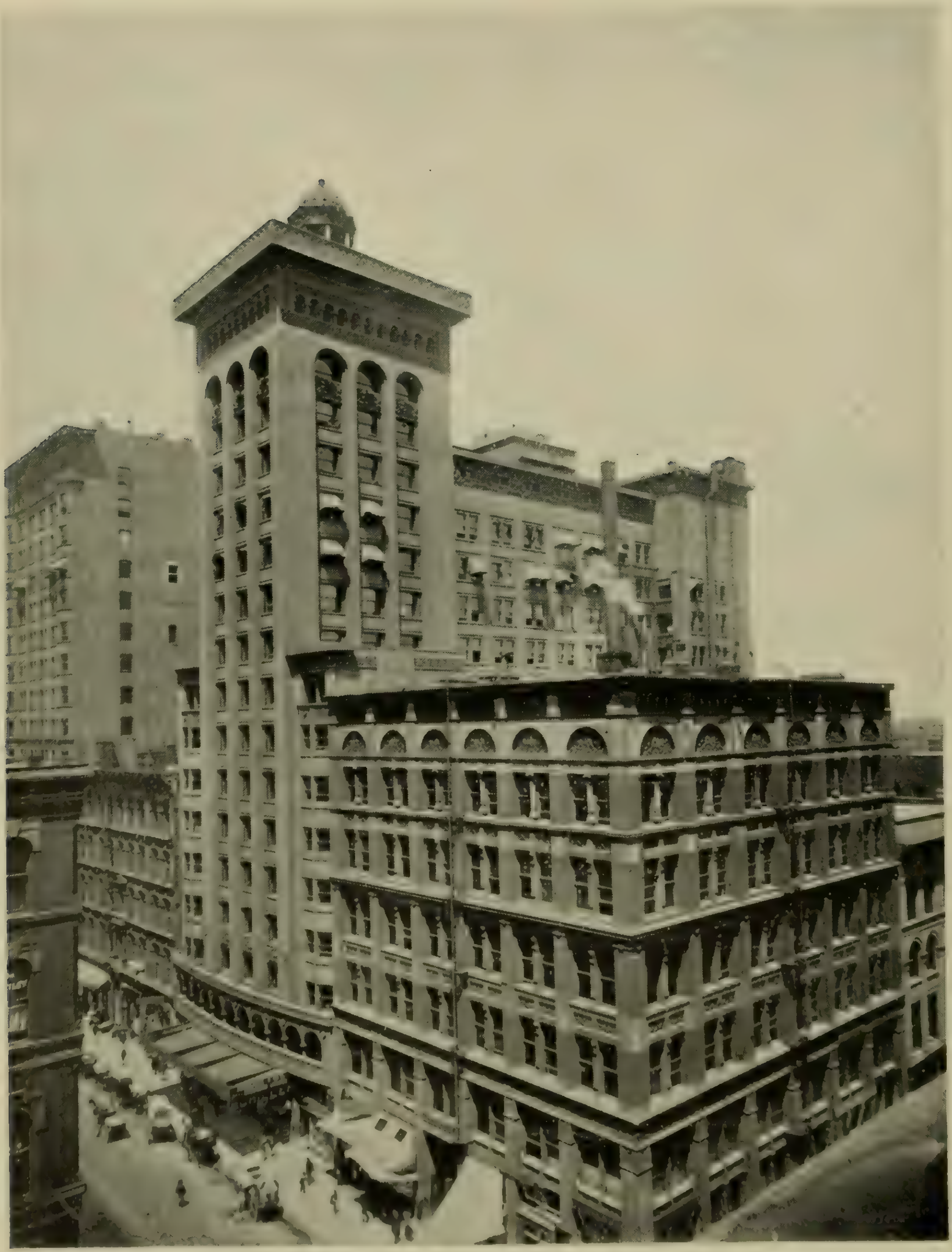
These things, however, are scarce more than a drop in the vast well of architectural betterment that is needed in every American city, and very foolish and insignificant they are, compared with what may be seen abroad, both in the capitals and in the second- and third-rate cities that few take the trouble to visit. We have fine sites and costly structures, and our men of wealth do not stint expenditure on buildings for their own use; but the results are not always good in themselves or in their individual parts. Take, for example, City Hall park in New York, and the streets that surround it. Though the park is small, the buildings on Broadway and Park row are sufficiently distant from each other to escape the appearance of crowding. Neglecting the buildings in the park, and the horrible structure used by the national government as a post office and court house that shuts in one end, and neglecting, also, the older buildings still remaining, the sum of $10,000,000 would be a conservative estimate of the money expended in the last ten years upon the great buildings that now look down upon the little City Hall in the centre of the green. This is a considerable sum of money, and in the hands of the French government would have secured for the city in which it was spent at least one monumental building of a real artistic value, or a whole series of structures of which each, we may be sure, would have been a true municipal ornament.

It is needless to say that we have none of this in the neighborhood of the City Hall Park. The new buildings are large and costly, but, with the exception of the Times and the Home Life buildings, both of which are open to criticism, there is not one that might not, with the utmost benefit to art, be swept off the face of the earth. Yet this very place, the heart of New York's municipal life, is the spot of spots that calls for careful and artistic treatment, and where fine buildings could not but have an ennobling effect upon the vast numbers of people who daily pass through it. It is little wonder, when one thinks of the abominable buildings that are shutting in this breathing place, that it is frequented by loafers and thugs. Were the surroundings of the splendor suited to the place, who can tell but that it might become "too stylish" or too refined for the People who now make it a place of common resort !

Much more happy in the buildings that surround it, though at the same time a conspicuous example of the difficulties under which the architecture of cities is improved in America, is the Plaza at the entrance to Central Park at Fifty-ninth street and Fifth avenue. This is scarce more than the junction of two streets, but the open park on one corner and a little open area within the space of junction give an airiness and spaciousness to it that are quite unusual for so limited a spot. Architecturally, this is the most monumental quarter in New York, though it will speedily be exceeded, in this respect, by the new buildings on the upper west side, which will include the cathedral of St. John the Divine, Columbia College, and St. Luke's Hospital.

Yet everything here has been done by private enterprise, and at various periods. On one side is the vast red brick and terra cotta bulk of the Plaza Hotel,—not a notable structure in itself, but, like the larger Savoy Hotel opposite, devoid of any marked unpleasantness of design. On the lower side is the palace built by Mr. Vanderbilt,—a picturesque pile that is the most spacious private city residence in America. Opposite the Plaza Hotel is an apartment house, the Savoy Hotel, and the ungainly but striking Netherlands Hotel. Beyond is the beautitul house of the Metropolitan Club, with Mr. Gerry's residence next to it.

If we close our eyes to many deficiencies in detail and in composition of most of the structures in this group, it must be admitted that the general effect is fine. The buildings are large and have a certain air of splendor that properly accompanies liberal expenditure. Their greatest misfortune is that there is no balancing of parts, and none of that relationship which should exist between the members of a group



THE SCHILLER THEATRE, CHICAGO.

such as these buildings form. Not that, on a place like this, we should necessarily have symmetrical buildings, once so popular in Europe, and of which the Place Vendome in Paris and the Place de la Bourse in Bordeaux are striking examples, more successful than the many places, crescents, and circusses of London. We do not need a cold formalism in our architecture, or a duplication of designs, for a good effect around an open space; but certainly the result would have been happier, had the designs of the different buildings been conceived from the point of view of an *ensemble*, instead of singly and separately, regardless of relationship.

Of all the buildings that compose this group the most notable is the house of the Metropolitan Club. It is the one building that speaks for art alone, and which has a monumental value that the more utilitarian structures near it cannot have. It strikes a new note in the picture, a note of art and of beauty, of refinement, of purity of line, of fine proportions, of skilful workmanship, of noble purpose. I should be loath to characterize this building as the finest structure in New York, but I am confident I shall not be misunderstood when I say that I know no other public or semi-public building that is as great an ornament to the metropolis as this, or one that can teach so direct and simple a lesson of the value of art—a lesson which is all the more pointed because of the proximity of other great buildings less happily designed.

This is a conspicuous instance of the way in which our wealthy men are beautifying our American cities, though in every case they first consider their own pleasure. There are many others. We now have scarce a city in which there is not a series of private residences whose artistic beauty makes them real landmarks in the wilderness of mediocrity once seemingly so popular. Compare Seventy-second street in New York, for example, with some of the newer streets on the upper west side. The former is one of the most distressing thoroughfares in the world, lined with dwellings whose average commonplaceness is something astonishing, and beside which the featureless buildings along the Rue de Rivoli in Paris, such as the Magasins du Louvre, the Hotel Continental, and the like, have a quiet restfulness that is almost beautiful. In the newer districts of New York are many examples of the work of the individual architect who loves his task and designs with a serene consciousness of artistic ability. Nor is the new movement confined to one city. Philadelphia, that architectural nightmare which has become a byword among nations, has now, thanks to a small company of architects, among whom Mr. Wilson Eyre, Jr., and Mr. Frank Miles Day are the most conspicuous, many notable private dwellings that in artistic feelings and design are among the most interesting yet built in this country.

And so in other cities. In Washington, Boston, Chicago, St. Louis, Denver, and Minneapolis, friendly eyes will find much to praise, much to rejoice at, as indicative of good times for art, not coming, but already arrived. In some of these it will be the semi-suburban house that will prove the most attractive and offer the best illustration of artistic workmanship. In Chicago it is the business buildings, like the Auditorium, the Schiller theatre, the Monadnock Block, the Stock

Exchange, the Old Colony Building, and others, that command attention by reason of their artistic treatment and the comparison they offer with more ornate and less logically designed structures in the east.

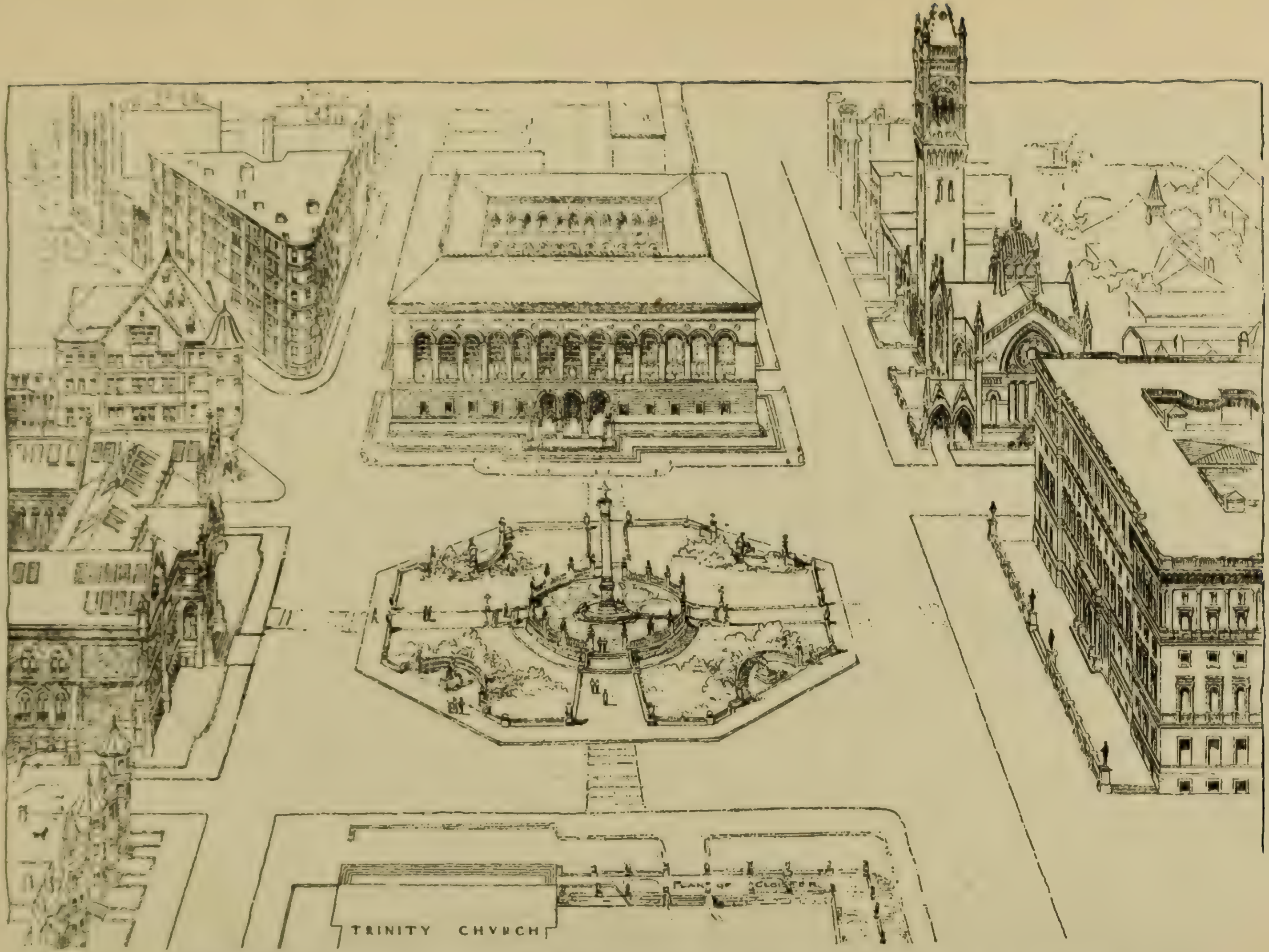
The formation of Municipal Art Societies, in New York, Philadelphia, Boston, and Chicago, in the last year or two, is another notable sign of the progress of municipal art. True, some of these societies have in view only the encouragement of painting and decorating public buildings; but others include a broader view, and hope, in time, to influence architecture and the general aspect of our cities.

All of this means a good deal. It means more than architectural progress; more than a broadening of architectural appreciation; more than a simple wish to own the handsomest house or the most costly office-building. It means a real growth in artistic sentiment, and the opening up of a new source of educative influence to the people. It is good to walk through a street lined with artistic buildings; or, in a ramble in the country, to come upon a house that attracts by its beauty and the art of its surroundings; or to wander through the palatial courts and corridors of a Ponce de Leon. It is good to have art in the design of the house as well as within its walls; to spread it forth in our business buildings as well—let us hope that time will come—as upon our civic structures. A good building is like a good thought,—pure, elevating, ennobling. We can live in an ugly house and transact business in a monstrosity; but surely it is an added joy in life to have our houses fine and beautiful, and our commercial buildings spacious and monumental. Compared with what other people have had to work with, our opportunities are small and our difficulties great. Yet even within our narrow limits a good deal has been accomplished, and, with the spread of architectural appreciation that must inevitably come with time, much more will be done. But we must realize our limitations, and then, instead of deploring our lot, set to work to do the best we can within them. When a great business corporation, like the Metropolitan Life Insurance Company, will spend a very large sum in erecting a monumental court in their chief office building in New York, a court designed with fine artistic skill, set off with rich marble and onyx and bronze, to be completed, in time, with paintings on the enclosing walls,—when a business corporation carries out so notable a work as this, without utility in its costliness or necessary structural value, but purely as a work of art to delight the eye, then surely a new spirit of beauty has come upon our architecture that cannot but give to it an ethical value it cannot have when purely utilitarian.

Good architecture, fine architecture, monumental architecture, have a distinct value to the community in which they are found. As wealth attracts wealth, so beauty brings beauty. It is not, indeed, pleasant to think that Mr. A. has built a superb house only because Mr. B.'s new mansion was more imposing than the house Mr. A. had been living in. Yet this rivalry is a healthful one and old. Each medieval bishop wanted a finer cathedral than his brother bishop had, and forthwith churches were pulled down and new ones erected that are still the marvel of every beholder. Each Italian prince, and each great nobleman of France, must needs have a new palace or a fresh château finer than any other, when the architects of the Renaissance had showed how to build them in the new style. A great gulf of art as well as of time separates us from these doings, but this ancient spirit has not yet been extinguished; and, though we operate on a smaller scale, we are doing the very sort of thing that produced the world's greatest monuments of art. It is true that some commercial corporations still imagine, with that soullessness for which corporations are proverbial, that height and size and cost are the proper measures to be applied to excellence in architecture. But the later building, though it be larger and higher and more costly than any of its predecessors, will show an artistic advance that is not the less significant because associated with unartistic conditions.

Much that has been done in the way of good architecture in this country has had its origin in motives that may be termed personal or selfish, and without regard to the effect upon what others have done. The men who built the palaces of Newport did so because it was congenial to their tastes to live in sumptuous dwellings. But these imposing villas and mansions have a value to the community of Newport, and to the many visitors to that famous watering-place, that is quite distinct from the satisfaction they give their owners. Still, though the larger part of our civic adornment has been done in this purely personal way, we can count some monuments—few and far between, perhaps—which, at the outset, were intended to have, and which do have, a direct influence upon the public. The Metropolitan Club and the Washington Arch are examples of this proper public spirit in New York. Boston has its beautiful Public Library—one building in a group surrounding Copley square which, taken all in all, is perhaps the most successful monumental group in America. Chicago has its Art Institute and its Newberry Library, and a few other buildings throughout the country testify to the same spirit. Truly, if it is well to adorn our cities with such noble buildings as these, will it not be better to add to their quantity and their quality with each new undertaking?

The beginnings of such a movement have already taken root among us, not in one community, but in many; and, as time speeds on, it must gather strength and spread, adding to the attractiveness of our



SCHEME FOR THE DECORATIVE TREATMENT OF COPLEY SQUARE, BOSTON. BY W. G. PRESTON.

cities and lightening the dreary lives of the people within them, who know no beauty but that which they see upon the streets. We may be thankful for what has been accomplished; but much must be done before we can look with satisfaction upon the artistic aspects of American cities.

And has good architecture an elevating and educational effect upon the people? The question scarcely needs to be propounded. Many a time I have seen the workingmen and peasants in France gazing earnestly at the fine buildings that make that country a veritable treasure-house of art. It needs no argument to insist on the utility of such structures, for, though an uneducated person will not derive from them that joy and satisfaction that is natural to the trained mind, a noble building can not be seen without producing at least some effect of good. In our own country the value of good architecture is not so much appreciated as abroad; else the appearance of our cities would be less open to criticism. Our people gaze with wonderment upon the palaces of Mr. Vanderbilt and Mr. Astor, at the Metropolitan Club, or at the vastness of the building of the American Surety Company. It is doubtless true that it is not the art of these buildings that attracts, so much as their size and cost and the fact that they belong to well-known people. Grant that, if you will; still does not the greater fact remain that it is better they should have an art quality than none at all, and that at least some memory of their beauty will be taken away?

Have you ever watched the people who stop to gaze at the contents of the windows of the art shops, or who crowd the art museums on a Sunday or a holiday? What matters it if the comments are ill-judged or thoughtless; it is enough that people look at beautiful things and enjoy them, even in a homely and commonplace way. If beauty is present, a constant looking at it must produce a good effect. So with architecture. A good building is as easy to build as a bad one, and costs no more. All such structures have an art value for the people which is not to be measured in money, and which must, in time, influence our national life and thought as the beautiful buildings of Europe do in those communities of which they have so long been the chief ornament.

A PIECE-RATE SYSTEM AND SHOP MANAGEMENT.*

By Fred. W. Taylor.

THE ordinary piece-work system involves a permanent antagonism between employers and men, and a certainty of punishment for each workman who reaches a high rate of efficiency. The demoralizing effect of this system is most serious. Under it even the best workmen are forced continually to act the part of hypocrites, to hold their own in the struggle against the encroachments of their employers.

The system introduced by the writer, however, is directly the opposite, both in theory and in its results. It makes each workman's interest the same as that of his employer, pays a premium for high efficiency, and soon convinces each man that it is for his permanent advantage to turn out each day the best quality and maximum quantity of work. The system consists of three principal elements:

(1) An elementary rate-fixing department.
(2) The differential-rate system of piece-work.
(3) What he believes to be the best method of managing men who work by the day.

Elementary rate fixing differs from other methods of making piece-work prices in that a careful study is made of the time required to do each of the many elementary operations into which the manufacturing of an establishment may be analyzed or divided. These elementary operations are then classified, recorded, and indexed, and, when a piece-work price is wanted for work, the job is first divided into its elementary operations, the time required to do each elementary operation is found from the records, and the total time for the job is summed up from these data.

The differential-rate system of piece-work consists, briefly, in offering two different rates for the same job; a high price per piece, in case the work is finished in the shortest possible time and in perfect condition, and a low price, if it takes a longer time to do the job, or if there are any imperfections in the work. (The high rate should be such that the workmen can earn more per day than is usually paid in similar establishments.) This is directly the opposite of the ordinary plan of piece-work, in which the wages of the workmen are reduced when they increase their productivity.

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* The paper here presented in abstract was read by Mr. Taylor at the Detroit meeting of the American Society of Mechanical Engineers in June, 1895. At that time it attracted much attention and favorable comment. We regard it as one of the most valuable contributions that have ever been given to technical literature, and by reason of that fact, together with the revival of manufacturing activity which has set in, we deem it eminently fitting to accord the paper that distinction which its importance and originality unquestionably merit.—THE EDITOR.

The system by which the writer proposes managing the men who are on day-work consists in paying *men* and not *positions.* Each man's wages, as far as possible, are fixed according to the skill and energy with which he performs his work, and not according to the position which he fills. Every endeavor is made to stimulate each man's personal ambition. This involves keeping systematic and careful records of the performance of each man, as to his punctuality, attendance, integrity, rapidity, skill, and accuracy, and a readjustment from time to time of the wages paid him, in accordance with this record.

The advantages of this system of management are:

First. That the manufactures are produced cheaper under it, while at the same time the workmen earn higher wages than are usually paid.

Second. Since the rate-fixing is done from accurate knowledge, instead of more or less by guess-work, the motive for holding back on work, or "soldiering," and endeavoring to deceive the employers as to the time required to do work, is entirely removed, and with it the greatest cause for hard feelings and war between the management and the men.

Third. Since the basis from which piece-work as well as day rates is fixed is that of exact observation, instead of being founded upon accident or deception, as is too frequently the case under ordinary systems, the men are treated with greater uniformity and justice, and respond by doing more and better work.

Fourth. It is for the common interest of both the management and the men to coöperate in every way, so as to turn out each day the maximum quantity and best quality of work.

Fifth. The system is rapid, while other systems are slow, in attaining the maximum productivity of each machine and man; and, when this maximum is once reached, it is automatically maintained by the differential rate.

Sixth. It automatically selects and attracts the best men for each class of work, and it develops many first-class men who would otherwise remain slow or inaccurate, while at the same time it discourages and sifts out men who are incurably lazy or inferior.

Finally. One of the chief advantages derived from the above effects of the system is that it promotes a most friendly feeling between the men and their employers, and so renders labor unions and strikes unnecessary. There has never been a strike under the differential-rate system of piece-work, although it has been in operation for the past ten years in the steel business, which has been during this period more subject to strikes and labor troubles than almost any other industry.

The theory upon which the ordinary system of piece-work operates to the benefit of the manufacturer is exceedingly simple. Each workman, with a definite price for each job before him, contrives a way of doing it in a shorter time, either by working harder or by improving his method ; and he thus makes a larger profit. After the job has been repeated a number of times at the more rapid rate, the manufacturer thinks that he should also begin to share in the gain, and therefore reduces the price of the job to a figure at which the workman, although working harder, earns, perhaps, but little more than he originally did when on day work. The actual working of the system, however, is far different. Even the most stupid man, after receiving two or three piece-work "cuts," as a reward for having worked harder, resents this treatment, and seeks a remedy for it in the future. Thus begins a war —generally an amicable war, but none the less a war—between the workmen and the management. The latter endeavors by every means to induce the workmen to increase the output, and the men gage the rapidity with which they work so as never to earn over a certain rate of wages, knowing that, if they exceed this amount, the piece-work price will surely be cut, sooner or later.

But the war is by no means restricted to piece-work. Every intelligent workman realizes the importance, to his own interest, of starting in on each new job as slowly as possible. There are few foremen or superintendents who have anything but a general idea as to how long it should take to do a piece of work that is new to them. Therefore, before fixing a piece-work price, they prefer to have the job done for the first time by the day. They watch the progress of the work as closely as their other duties will permit, and make up their minds how quickly it can be done. It becomes the workman's interest then to go just as slowly as possible, and still convince his foreman that he is working well. The effect of this system of piece-work on the character of the men is, in many cases, so serious as to make it doubtful whether, on the whole, well-managed day-work is not preferable.

There are several modifications of the ordinary method of piece-work which tend to lessen the evils of the system, but I know of none that can eradicate the fundamental causes for war, and enable the managers and the men to heartily coöperate in obtaining the maximum product from the establishment. It is the writer's opinion, however, that the differential-rate system of piece-work in most cases entirely harmonizes the interests of both parties.

Coöperative experiments have failed, and, I think, are generally destined to fail, for several reasons, the first and most important of which is that no form of coöperation has yet been devised in which each individual is allowed free scope for his personal ambition. This always has been and will remain a more powerful incentive to exertion than a desire for the general welfare. The few misplaced drones, who do the loafing and share equally in the profits with the rest, under coöperation are sure to drag the better men down toward their level. The second and almost equally strong reason for failure lies in the remoteness of the reward. The average workman (I don't say all men) cannot look forward to a profit which is six months or a year away. Other and formidable difficulties in the path of coöperation are the equitable division of the profits, and the fact that, while workmen are always ready to share the profits, they are neither able nor willing to share the losses. Further than this, in many cases, it is neither right nor just that they should share either in the profits or the losses, since these may be due in great part to causes entirely beyond their influence or control, and to which they do not contribute.

When we recognize the real antagonism that exists between the interests of the men and their employers under all of the systems of piece-work in common use ; and when we remember the apparently irreconcilable conflict implied in the fundamental and perfectly legitimate aims of the two : namely, on the part of the men, *the universal desire to receive the largest possible wages for their time ;* and on the part of the employers, *the desire to receive the largest possible return for the wages paid,*—what wonder that most of us arrive at the conclusion that no system of piece-work can be devised which shall enable the two to coöperate without antagonism and to their mutual benefit? Yet it is the opinion of the writer that, even if a system has not already been found which harmonizes the interests of the two, still the basis for harmonious coöperation lies in the two following facts :

First. That the workmen in nearly every trade can and will materially increase their present output per day, providing they are assured of a permanent and larger return for their time than they have heretofore received.

Second. That the employers can well afford to pay higher wages per piece, even permanently, providing each man and machine in the establishment turns out a proportionately larger amount of work. The truth of the latter statement arises from the well-recognized fact that, in most lines of manufacture, the indirect expenses equal or exceed the wages paid directly to the workmen, and that these expenses remain approximately constant, whether the output of the establishment is great or small. From this it follows that it is always cheaper to pay higher wages to the workmen when the output is proportionately increased, the diminution in the indirect portion of the cost per piece being greater than the increase in wages. Many manufacturers, in considering the cost of production, fail to realize the effect that the volume of output has on the cost. They lose sight of the fact that taxes, insurance, depreciation, rent, interest, salaries, office expenses, miscellaneous labor, sales expenses, and frequently the cost of power (which in the aggregate amount to as much as wages paid to workmen) remain about the same, whether the output isgreat or small.

In our endeavor to solve the piece-work problem by the application of the two fundamental facts above referred to, let us consider the obstacles in the path of harmonious coöperation, and suggest a method for their removal. The most formidable obstacle is the lack of knowledge on the part of both the men and the management (but chiefly the latter) of the quickest time in which each piece of work can be done; or, briefly, the lack of accurate time-tables for the work of the place. The remedy for this trouble lies in the establishment in every factory of a proper rate-fixing department,—a department which shall have equal dignity and command equal respect with the engineering and managing departments, and which shall be organized and conducted in an equally scientific and practical manner.

The elementary system of fixing rates has been in successful operation for the past ten years, on work complicated in its nature, and covering almost as wide a range of variety as any manufacturing that the writer knows of. In 1883, while foreman of the machine shop ot the Midvale Steel Company of Philadelphia, it occurred to the writer that it was simpler to time each of the elements of the various kinds of work done in the place, and then find the quickest time in which each job could be done by summing up the total times of its component parts, than it was to search through the records of former jobs, and guess at the proper price. After practising this method of rate-fixing himself for about a year, as well as circumstances would permit, it became evident that the system was a success. The writer then established the rate-fixing department, which has given out piece-work prices in the place ever since. This department far more than paid for itself from the very start; but it was several years before the full benefits of the system were felt, owing to the fact that the best methods of making and recording time-observations of work done by the men, as well as of determining the maximum capacity of each of the machines in the place, and of making working-tables and time-tables, were not at first adopted.

A man whose business it is to fix rates soon becomes so familiar with the time required to do each kind of elementary work performed by the men that he can write down the time from memory. In the case of that part of the work which is done by the machine, the rate-fixer refers to tables which are made out for each machine.

While, however, the accurate knowledge of the quickest time in which work can be done, obtained by the rate-fixing department and accepted by the men as standard, is the greatest and most important step towards obtaining the maximum output of the establishment, it is one thing to know how much work can be done in a day, and an entirely different matter to get even the best men to work at their fastest speed or anywhere near it.

Whether coöperation, the differential plan, or some other form of piece-work be chosen, in connection with elementary rate-fixing, as the best method of working, there are certain fundamental facts and principles which must be recognized and incorporated in any system of management, before true and lasting success can be obtained; and most of these facts and principles will be found to be not far removed from what the strictest moralists would call justice. The most important of these facts is that *men will not do an extraordinary day's work for an ordinary day's pay;* and any attempt on the part of employers to get the best work out of their men and give them the standard wages paid by their neighbors will surely be, and ought to be, doomed to failure.

Justice, however, not only demands for the workman an increased reward for a large day's work, but should compel him to suffer an appropriate loss, in case his work falls off either in quantity or quality. It is quite as important that the deductions for bad work should be just, and graded in proportion to the shortcomings of the workman, as that the reward should be proportional to the work done. The fear of being discharged, which is practically the only penalty applied in many establishments, is entirely inadequate to producing the best quantity and quality of work; since the workmen find that they can take many liberties before the management makes up its mind to apply this extreme penalty.

It is clear that the differential rate satisfies automatically, as it were, the above conditions of properly-graded rewards and deductions. Whenever a workman works for a day (or even a shorter period) at his maximum, he receives under this system unusually high wages; but, when he falls off either in quantity or quality from the highest rate of efficiency, his pay falls below even the ordinary. The lower differential rate should be fixed at a figure which will allow the workman to earn scarcely an ordinary day's pay when he falls off from his maximum pace, so as to give him every inducement to work hard and well. The exact percentage beyond the usual standard which must be paid to induce men to work to their maximum varies with different trades and with different sections of the country.

It is not, however, sufficient that each workman's ambition should be aroused by the prospect of larger pay at the end of even a comparatively short period of time. The stimulus to maximum exertion should be a daily one. This involves such vigorous and rapid inspection and returns as to enable each workman in most cases to know each day the exact result of his previous day's work,—*i. e.*, whether he has succeeded in earning his maximum pay, and exactly what his losses are for careless or defective work. Two-thirds of the moral effect, either of a reward or penalty, is lost by even a short postponement. And it is equally important for the management to know whether the work has been properly done.

As far as possible, each man's work should be inspected and measured separately, and his pay and losses should depend upon his individual efforts alone. It is, of course, a necessity that much of the work of manufacturing—such, for instance, as running roll-trains, hammers, or paper machines—should be done by gangs of men who coöperate to turn out a common product, and that each gang of men should be paid a definite price for the work turned out, just as if they were a single man. In the distribution of the earnings of a gang among its members, the percentage which each man receives should, however, depend not only upon the kind of work which each man performs, but upon the accuracy and energy with which he fills his position. In this way the personal ambition of each of a gang of men may be given its proper scope. Again, we find the differential rate acting as a most powerful lever to force each man in a gang of workmen to do his best; since if, through the carelessness or laziness of any one man, the gang fails to earn its high rate, the drone will surely be obliged by his companions to do his best the next time or else get out.

A great advantage of the differential-rate system is that it quickly drives away all inferior workmen, and attracts the men best suited to the class of work to which it is applied; since none but really good men can work fast enough and accurately enough to earn the high rate, and the low rate should be made so small as to be unattractive even to an inferior man. If for no other reason than that it secures to an establishment a quick and active set of workmen, the differential rate is a valuable aid, since men are largely creatures of habit; and if the piece-workers of a place are forced to move quickly and work hard, the day-workers soon get into the same way, and the whole shop takes on a more rapid pace.

The greatest advantage, however, of the differential rate for piece-work, in connection with a proper rate-fixing department, is that together they produce the proper mental attitude on the part of the men and the management toward each other. In place of the indolence and indifference which characterize the workmen of many day-work establishments, and to a considerable extent also their employers ; and in place of the constant watchfulness, suspicion, and even antagonism with which too frequently the men and the management regard each other, under the ordinary piece-work plan,—both sides soon appreciate the fact that with the differential rate it is their common interest to coöperate to the fullest extent, and to devote every energy to turning out daily the largest possible output. This common interest quickly replaces antagonism, and establishes a most friendly feeling.

Of the two devices for increasing the output of a shop, the differential rate and the scientific rate-fixing department, the latter is by far the more important. The differential rate is invaluable at the start, as a means of convincing men that the management is in earnest in its intention of paying a premium for hard work, and it at all times furnishes the best means of maintaining the top notch of production ; but, when, through its application, the men and the management have come to appreciate the mutual benefit of harmonious coöperation and respect for each other's rights, it ceases to be an absolute necessity. On the other hand, the rate-fixing department, for an establishment doing a large variety of work, becomes absolutely indispensable. The longer it is in operation, the more necessary it becomes.

The term " rate-fixing department " has rather a formidable sound. In fact, however, that department should consist, in most establishments, of one man, who, in many cases, need give only a part of his time to the work.

When the manufacturing operations are uniform in character, and repeat themselves day after day,—as, for instance, in paper or pulp mills,—the whole work of the place can be put upon piece-work in a comparatively short time ; and, when once proper rates are fixed, the rate-fixing department can be dispensed with, at any rate until some new line of manufacture is taken up.

The system of differential rates was first applied by the writer to a part of the work in the machine shop of the Midvale Steel Company, in 1884. Its effect in increasing and then maintaining the output of each machine to which it was applied was almost immediate, and so remarkable that it soon came into high favor with both the men and the management. It was gradually applied to a great part of the work of the establishment, with the result, in combination with the rate-fixing department, of doubling, and in many cases trebling, the output, and at the same time increasing, instead of diminishing, the accuracy of the work. In some cases it was applied by the rate-fixing department without an elementary analysis of the time required to do the work ; simply offering a higher price per piece providing the maximum output before attained was increased to a given extent. Even this system met with success, although it is by no means correct, since there is no certainty that the reward is in just proportion to the efforts of the workmen.

In cases where large and expensive machines are used, such as paper machines, steam hammers, or rolling mills, in which a large output is dependent upon the severe manual labor as well as the skill of the workmen (while the chief cost of production lies in the expense of running the machines rather than in the wages paid), it has been found of great advantage to establish two or three differential rates, offering a higher and higher price per piece or per ton as the maximum possible output is approached.

The rate-fixing department has shown the necessity of carefully systematizing all of the small details in the running of each shop ; such as the care of belting, the proper shape for cutting tools, oiling machines, issuing orders for work, obtaining accurate labor and material returns, and a host of other minor methods and processes. These details, which are usually regarded as of comparatively small importance, and many of which are left to the individual judgment of the foreman and workmen, are shown by the rate-fixing department to be of paramount importance in obtaining the maximum output, and to require the most careful and systematic study and attention in order to insure uniformity and a fair and equal chance for each workman Without this preliminary study and systematizing of details, it is impossible to apply successfully the differential rate in most establishments.

The following table, from results in actual practice, will show the economy of paying high wages under the differential rate, as compared with the ordinary piece-work system. The work consisted in turning certain forgings.

COST OF PRODUCTION PER LATHE PER DAY.

Ordinary system of piece-work.		*Differential-rate system.*	
Man's wages	$2.50	Man's wages	$3.50
Machine cost	3.37	Machine cost	3.37
Total cost per day	$5.87	Total cost per day	$6.87
5 pieces produced.		10 pieces produced.	
Cost per piece,	$1.17	Cost per piece	$0.69

This result was mostly, though not entirely, due to the differential rate. The superior system of managing all of the small details of the shop counted for considerable.

THE LAW OF WATER, AND MODERN IRRIGATION.

By Richard J. Hinton.

ON the 22d of July, 1895, United States Circuit Judge E. M. Ross delivered at Los Angeles a decision of momentous importance to all irrigation interests. The case before him was that of Maria K. Bradley *vs.* the Fallbrook irrigation district, San Diego Co., Cal., being a suit in equity by which it was sought to enjoin the execution of a deed for forty-one acres of land owned by Mrs. Bradley, under a sale by the collector of the Fallbrook irrigation district to satisfy a delinquent assessment held against property under the district act. The complainant alleged that this was not in accordance with the provisions of the constitution of the State, and that it conflicted with the federal constitution, as it attempts to deprive an individual of property without due process of law, and also takes private property for the use of a private corporation.

The judge sustained the allegations, and declared the irrigation district laws to be in conflict with the federal constitution. He further declared that the use for which said property is authorized by the State laws to be taken "is not a public use;" therefore such taking, use, taxation, and delinquent sales are infringements of the guaranteed rights of citizens.

Every question raised in the Bradley suit has been argued before, and decided the other way by the State supreme court, on appeals from superior courts. Some twenty judges of the higher court, and as many more of other State courts, have since 1888 affirmed the constitutionality of each issue now negatively decided by Judge Ross. The latter declares that the issues of uses involved are like those of commercial character, not to be wholly decided by State supreme courts, and that the legislative action declaring such use of water to be a public one cannot lawfully make it so. The character of use is not to be tested by the number of users merely, for the fact that all are not allowed to use is a measure adverse to public service and character. Property owners cannot be constrained to such class use, even though the general public may be more benefited by it than by their own use of lands. "It is extremely plain," declares the federal judge, "that the legislative purpose . . . . cannot be indicated in the plea that it directly conduces to the general welfare of the community." But, following this, he declared that taxation for drainage purposes of overflowed lands (tule) is a public use, because it largely "increases production." Such increase in California, through irrigation reclamation, is a hundred per cent. greater according to areas than all the results of reclamation drainage. But for the building up of great commonwealths, whose prosperity and security depend almost wholly upon such water service, Judge Ross can only say: "I can see no rational ground for the assumption that the schemes to be executed by this act are, in the main, matters which in any just sense can be said to be of public concern."

There is abundant testimony to the effect that one ordinary acre of irrigated land under cultivation will produce as much as three equivalent acres in the United States. France supports in comfort one person per acre. In this country it takes at least three acres to support a single person. On either estimate the enormous importance of western irrigation to the United States may be easily comprehended, since the population that could be supported on our arid lands under irrigation would be not less than thirty-three million and might reach one hundred million. The jurisprudence, then, that must largely shape such great possibilities is certainly a matter of high significance.

From the dawn of history agriculture appears to have begun in arid regions, or in those where enormous evaporation under tropical heat compels artificial water storage and distribution. Ancient civilizations of the most imposing proportions have been borne, economically speaking, upon this form of industry. At the present day one-third of the world's population raise their food supplies by the aid of irrigation. On this continent alone fifteen millions are largely dependent thereon, and the range increases. What, then, is the controlling principle called the law of water? It may be thus summarized:

No property character, and non ownership, public or private; a public trust, to be used for beneficial purposes only; accessibility by all to what is a natural element, essential to life and necessary for industry. These are primal and controlling principles. They cannot be overthrown, and must be followed, if peace be maintained, wherever arid conditions exist. Water possesses no characteristic of property, for it may not be found in place and cannot be identified. Being a natural element, if subjected to usufructuary conditions, it becomes a trust regulated by the sovereignty, and must be held for the common good. This is the rule of the Chinese irrigators with their petty water-wheels and bamboo pipes. It is the law of the great Anglo-Indian works, and the custom of the millions of Hindoo ryots who use water from shallow wells. It is the habit of the nomadic shepherds of Central Asia, and of the Egyptian fellahs who live by the Nile. Everywhere the principle at the back of all use and supervision in Italy, Spain, France, or elsewhere—whether appliances are rude or scientific—is that of public control. The State may not dispose of it, but it must administer it for beneficial use alone. Even we are doing this, and have been for forty years, under the somewhat clumsy device called "prior appropriation." The result of use may become both personal and profitable ; the thing used cannot be considered the one or made into the other. So the State cannot surrender ; the individual may not control. The cost of use and the means of storage, conveyance, and distribution, involves payment therefor. In this way the enterprise of man finds a legal and legitimate return.

Judge Ross has, as has been already stated, adversely decided the question of the constitutionality of the State laws under which municipal districts have been formed to appropriate water, construct and own works, to irrigate lands from a common source under public direction, and permit the use of interest-bearing bonds with incidence of taxation for their payment. Necessarily, taxation carries with it the power of enforcement, and the sale of lands when owners are delinquent. Over thirty districts, large and small, have been organized. Bonds to the amount of about forty million dollars have been voted, and over half of these are negotiated. The opposition to the "Wright laws," as the statutes are termed, arises almost entirely from the possessors of large tracts of unused land and other influences at the back of them. It being found impracticable to destroy the law of water, the effort has been unremittent for its nullification : first, upon the plea that such use of water is not a public one ; second, that the State has no power to create such a municipal corporation as an irrigation district ; and, third, that it is an infringement of guaranteed rights to take property for the "private benefit" of others. All these questions have been systematically raised since 1887, in the State courts. The Wright laws require judicial confirmation of proceedings under them. In the course of such action, the issues have been uniformly settled in favor of the laws and upon the direct ground of public good. The State supreme court has, on appeal, rendered a score of such decisions. The federal judge ignores all this. He made caustic criticisms upon the laws in detail. These, however, are amendable by legislation, and his criticism could not permanently sustain destruction. What Judge Ross declares is that irrigation is a matter of private business and profit, not so public in character as to make constitutional the power of condemnation, the application of eminent domain, or sale for delinquent taxes. Upon the first and the last dicta, he would destroy the most important industry in California. The effect will be disastrous to all the arid region. The district system, in whole or part, is now operative in Washington, Oregon, Nebraska, Kansas, and the two Dakotas. It has been provided for in Idaho also, while in all these States, and in Nevada, Montana, Colorado, Utah, and Wyoming, the constitutions under which they have been admitted into the Union, and the laws also, provide for State control, beneficial use, prior appropriation, public record, control of works, and regulation of rates for storage or ditch conveyance. The whole burden and purpose of State jurisprudence are in vigorous antagonism to the decision of Judge Ross in the case of certain persons versus the District of Fallbrook, San Diego, which is now on the appellate calendar of the United States supreme court. The State of California has joined with the district in the appeal from the circuit court. Judge Ross bases his declaration of unconstitutionality of irrigation laws taxing lands and then selling them for delinquency, upon the fourteenth amendment,—an instrument made to protect the public and personal rights of a race that had been held as slaves. Whether the federal judge meant it or not, the result is, so far as his decision goes, to nullify the treaty of Guadaloupe-Hidalgo, to override the law of appropriation, to do that which the federal judiciary systematically avoids doing whenever possible,—*i. e.*, take action counter to the decision of State supreme courts,—and to place the future of a great region and its industrial development under the control of land-owners who notoriously play the *rôle* of the "dog in the manger." In effect, then, the decision is that the tillers of land who do work and who must have the water shall not have access thereto or be able to convey the same, if objection be made by owners who will not sell, work their land, or join in allowing work to be done by any one else.

To illustrate how hostile the Ross decision must prove, let me summarize the general situation in the arid region as to the law of water. It is recognized:

(1) That the principle of public control and beneficial servitude, as well as of free access, comes to us by the Code Napoleon and the Roman law, and by the immemorial customs of ancient peoples whether native, conquerors, or colonists. These rights, customs, and laws are guaranteed by solemn treaties.

(2) That, under the practice of equity in dealing with public lands in arid and semi-arid conditions, the United States departments and the judiciary have heretofore held strictly to the law of use and access. The land office recognizes prior appropriation for use; the interior department has systematically protected that, and the Pueblo and other Indians also in their water rights; and as late as 1880 and 1881 the executive ordered troops into Texas and New Mexico to guard rights of this character against encroachments affecting the Mexican and Indian users.

(3) That the United States congress adopted the miners' code, or common law, relative to the use of water, by appropriation, and made the same a part of the federal statutes. This is a distinct recognition of "public concern." It has been broadly interpreted by the courts ever since. Every one of the seventeen States and territories found, in whole or part, west of the one hundredth meridian has adopted the same and wrought it into constitution and statutes. In addition, by law, the customs and regulations of Mexico remain substantially part of the laws of Texas, Oklahoma, New Mexico, Arizona, Utah, Colorado, California, and Nevada.

(4) The States of Colorado, California (by amendment), Idaho, Montana, Nevada, North Dakota, Utah, Washington, and Wyoming have distinctly incorporated the principle of public control into their several constitutions.

(5) The States of Kansas, Nebraska, Oregon, South Dakota, and Texas have done the same by the adoption of recent and elaborate legislation on this whole subject.

A brief and pointed digest of the decisions reached by the courts of the arid States, especially in Colorado, Wyoming, Idaho, and California, will clearly show how far and how deliberately Judge Ross's view places him in antagonism to the general jurisprudence.

If the right of public control and beneficial use thereunder, and of prior appropriation of water, be conceded, it follows, as the day follows the night, that there must also be the right of way for "works of necessity." And it follows as certainly that irrigation works are among those of paramount need. The methods of achieving this use belong to the community. And it is as certain that the judiciary of the States are facing the other way. The right to take and use "private lands" for irrigation purposes is the constitutional law of half the arid States, and the statute law of the remainder. Some are more positive in declaration than others; but all acknowledge and act. Compensation must be made for such right of way. Supposed or hypothetical damages to land other than that actually used are not allowed. In other words, the ditch is "a primary need," and must be allowed. With the water it is to convey, its route and character fall within the lines of public supervision and trust. The "consent" of land-owners is not necessary, for "private ways of necessity" or for "reservoirs, drains, flumes, or ditches," when required for agricultural purposes. Every natural stream, it is declared, belongs to the State. In California, Nevada, and the States of the great plains, the State regulates and controls, as a "public concern," the use of "still" waters and of artesian or other underflow and subsurface supplies. Springs are also recorded. Unappropriated waters are dedicated "to the use of the people.'' The ownership—*i. e.*, the control—is ''vested'' in the State for the public. Colorado courts are, so far, in the front line of such decisions, but they only emphasize—and do not outrun—the others. Appropriation ''may never be denied,'' though limited by the paramount law of use. Preference is, in general, given to agricultural uses; then, in order thereafter, domestic, mining, manufacturing, power. Riparian rights are ignored, or made wholly secondary, their equities alone being considered. Water taken thereunder must be restored to the stream, and owners must use. Water, by all this practice and the importance it assumes, is changed from ''a mere incident to the soil'' into the condition of a ''usufructuary estate.'' Once used on land, it becomes an escheat thereof. The declaration is made that ''it is and always has been the duty'' of government ''to protect the right of water'' in this section, ''by priority of appropriation.'' This right is ''prior to legislation,'' and ''exists after patent'' as before. It does not matter whether the water and its use are related to the public domain or private demesne. The test of appropriation is always beneficial use. The water taken must be openly conveyed and visibly applied. Streams may be diverted from their usual course by proper methods, not injurious in their working. They may be stored and held for use, such use being, of course, subject to the rights of others. The legal rights of earlier appropriators must not be impeded or injured, nor can storage be permitted to ''lessen'' quantity, ''impair'' quality, or ''impede'' natural flow. Legislation may regulate, but not ''prohibit,'' the means necessary for ''beneficial use.'' It can regulate diversion, but it cannot directly ''grant'' or ''charter'' water. Abeyance of use cannot be permitted; the fact works forfeiture of appropriation. Use need not be limited to natural course or valley range; the diversion, when permitted, will allow of transfer from one watershed to another. Total change of route is in no way unlawful; priority still continues, and usufructuary rights are preserved. The legal power to determine rights is incidental to the ''regulation of use.'' The power to ''regulate rates,'' to determine costs, and to define the extent of service, follows logically from these premises. The States of Colorado, Idaho, Kansas, Nebraska, North and South Dakota, Wyoming, and California, have acted, in whole or part, upon this power. Texas statutes, with the territorial laws of New Mexico, and Arizona, operatively bring a similar result. These are all matters of judicial decision and affirmation in a number of States, but are especially present in the reports of Colorado, Idaho, and Wyoming.

So far it will be seen that the adjustments are along the line of persons and things rather than in their relations to persons and property, which, of course, involves profits and returns. The next step is as to the relation of works, ditches, etc., designed to store and convey for use the natural waters which, under priority of appropriation, the people have the right to command. The judiciary of the arid States—again most clearly that of Colorado, Wyoming, and Idaho—declare that ditch companies are "common carriers." The "reservoir," or "ditch," or "well," or "flume," is not a "consumer." Carrier belongs to the ditch; a "consumer" is the appropriator and user. The carrier may not charge in advance under the term "royalty" (Colorado decisions), as that is a usurpation of the generic "use" always involved in appropriation of water. "Royalty," in the vocabulary of water and ditch corporations, is a term used to indicate the demand for a certain sum per acre,—usually $10,—which is charged for the "privilege" of getting water to the land. It is easy to see how this could grow into a "vested right" barrier to free use. Colorado has definitely put both its judicial and legislative feet upon the plausibility, and declares that it is no part of the "carrier's" remuneration. At least three States—Colorado, Wyoming, and Idaho—have made it an unlawful practice. Common carriers are paid only for service performed. The main contention of the opposing school—that of the right to regard and treat water as a commodity—is thus denied. If the Ross decision stands as law, the commodity character will be achieved by indirection, wherever vacant land is privately owned and the owner is opposed to the present tendency.

The power of securing orderly distribution in equity of all waters is regarded as part of the State's police functions. "Courts," say Colorado judges, "would betray their trust . . . if they should shut their eyes and refuse to see" principles and operations "whose existence and recognition cannot be disregarded without bringing ruin on all." The statutes of all the arid States provide for the protection of works and of their owners; of lands and water users, so far as injury, misuse, pollution, cutting, etc., are concerned. Freedom from taxation is a favor usually granted for a term of years to ditch construction. Diligence is required in the work. Record of the route is demanded. Care in maintenance is to be enforced. Water, once attacked, remains with the soil,—so rule the courts of Colorado, Idaho, Wyoming, Montana, Nevada, Utah, and California. The others are following in the same lines. So also with the return to stream bed of all surplus water, and the decision that seepage waters are part of the natural supply; that flood waters are of the same character; and that reservoir sites, etc., are obtainable only by statute. Colorado and Wyoming provide elaborate machinery for supervision of hydrographic basins and for the government of water use. Kansas has a board of irrigation, investigation, and experiment. Nebraska has a board and office which are designed to be chiefly of engineering control. Nevada has a board of water commissioners, but so far it has done little. Idaho and South Dakota have State engineers; Washington, an arid-land commissioner; Montana, a board of land and water control. North Dakota has a commissioner of water and forestry. California was the first to authorize the office of State engineer, but it was unfortunately abolished some years since, in a spasm of mistaken economy. Wyoming, among all the arid States, is peculiarly fortunate in its State engineer, who presides also over the State board of control.

By the Carey law one million arable acres are granted to each State wherein irrigation is a prevailing need, provided it is accepted within ten years. Water must be arranged for in permanence, and actual settlers put upon the land, none to occupy over one hundred and sixty acres. There must be twenty acres in actual cultivation, with home residence on each quarter section, ere the State can receive and transfer the patents. Thus there will be at least 6,250 homesteads added to the State's population and resources. It is also required that all funds arising from land sales, etc., above cost, shall be deposited, with approval of the secretary of the interior, as a State trust fund to be used for reclamation purposes.

This is the federal gift and purpose. Under the Mead-Carey law in Wyoming it is provided by the State that the land shall be sold at fifty cents per acre; that the State will contract with construction companies to impound water and distribute the same by proper works; that for so doing it will guarantee efficient payment and profit by (*a*) encouraging and aiding settlement, (*b*) allowing a proper price per acre for the cost of water service, and (*c*) holding a lien on the homestead or acres served till the cost of the water right is paid; and that it will protect the user by providing that, when all the water rights are paid for, the works, *et al*, shall become public property under State supervision and to be administered by the users who are served under the supply thus made and arranged. There are three distinct conditions, then, in this legislation: (1) the general government's direct recognition of the public control and concern in irrigation reclamation; (2) the State's power to prevent extravagant land booming, by means of the small figure it cuts upon the acreage granted; (3) public control, and payment, through users, of a large profit to the contractors who provide the works.

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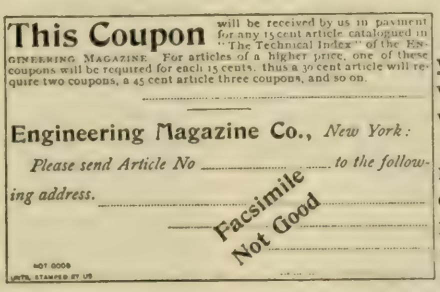

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ARCHITECTURE & BUILDING

Richard Morris Hunt.

THE *Architectural Record* for the quarter ending December, 1895, is given up to a review of the works of Richard Morris Hunt by Montgomery Schuyler. The text is a laudatory, but not injudicious, estimate of Mr. Hunt's career as an architect and of the artistic measure of his buildings. Mr. Schuyler regards Mr. Hunt's earlier works as displaying an oscillation from extreme formality to complete unrestraint, and adds that, in alternating, "he has shown no trace of severity in his lively performances, or of gayety in his gravity. In the works of his riper years and his practised powers, he seems to have retained this habit,—by turns to have restrained his designs in classic structures and to have relaxed it in freer architecture. But there is this great difference between the periods,—that, while his more formal works used to be liable to the charge of monotony, and his more exuberant works to that of restlessness, he has learned to combine his qualities, to give animation to works essentially academic, and repose to the children of his invention."

The article is sumptously illustrated, the pictures including many views, both exteriors and interiors, not before published, and offering, perhaps, greater interest to the architect than Mr. Schuyler's admirably-composed essay. The pictures include many views of the famous Biltmore house at Asheville, North Carolina, for Mr. George W. Vanderbilt, which are exclusively published and are certainly among the most notable photographs printed by this periodical. Some of them, it must be confessed, are a disappointment, the point of view being so distant that the vast house seems scarcely more than an incident in the landscape. Some of the larger views, however, give a better idea of the mansion, whose splendid size and unlimited cost have roused great expectations. These expectations are not unrealized, and there can be little doubt that Mr. Hunt's fame will largely rest upon this residence. The motifs are borrowed from the Château de Blois, and, if fault is found with the design,—though Mr. Schuyler does not suggest this phase of it,—it will be from the transposition of the features of the French building, and their rearrangement in a new combination. For example, Mr. Hunt, in his garden front, has introduced as a single design several features which in the original building are well separated and without hint of unity. One's sense of historical accuracy is somewhat hurt by a fresh combination of parts that, in the history of architecture, have a position almost consecrated in their relationship.

Several other notable buildings by Mr. Hunt are also illustrated in this article. Mr. Cornelius Vanderbilt's palatial villa, "The Breakers," at Newport, is shown within and without, the interior displaying a really sumptuous series of apartments, whose rich decorations are, to a large extent, architectural and constructive. These two Vanderbilt dwellings form the most conspicuous features of these illustrations, not only on account of their actual novelty, but because of their real value. The whole series of pictures is a most impressive display of architectural activity, remarkable alike for the variety of the styles in which their author worked, and for the thoroughness of his familiarity with a great quantity of detail. Though Mr. Schuyler finds considerable satisfaction in much of Mr. Hunt's early work, the unbiassed observer cannot but feel that in this great career there has been a very great architectural evolution, and that the early buildings show, to a very slight degree, that mastery of composition and of detail that made many of Mr. Hunt's later buildings among the most notable products of American architecture. As Mr. Schuyler remarks in closing, "the series of works here illustrated, and extending over forty fruitful years, shows an untiring zeal for a great art, a steadily-increasing skill and power in its practice, and constitutes a sum of achievement honorable to the artist, of good example to his profession, and creditable and useful to his country."

It was fitting that Mr. Henry Van Brunt, the most scholarly architect of America, and the one who, by the grace of his diction, the breadth of his views, and the soundness of his appreciation, has labored more zealously in diffusing a cultured knowledge of his art than any other living American architect, should have been chosen by the American Institute of Architects to render its tribute to the late Mr. Hunt. His memorial address, read at the last meeting of the Institute (*American Architect*, November 2; *Inland Architect*, November; *The Architect*, November 22), is a warmly sympathetic paper. It is a tribute of a friend as well as the estimate of a professional brother, and the interesting personal reminiscences that compose a large part of it, though dealin chiefly with the writer's early association with Hunt as a pupil, make it one of the most interesting and valuable papers that have been prepared on the great architect and his work.

Mr. Van Brunt modestly characterizes his paper as "the unaffected impressions of a man singularly representative of all the best qualities which can adorn an architect and a gentleman; a man to whom the profession in this country, for its own sake, owes a formal tribute of commemoration and acknowledgment; a man who not only won our respect and admiration for what he did, but our affection for what he was."

He points out that "the personal attributes of Hunt gave to his professional character a captivating animation, a frank sincerity, and these qualities, combined with the dignity of his bearing and his manly beauty, made him a notable individuality wherever he moved. His artistic conscience was not a mere instrument of service, to be laid aside when not in use, but an active and animating principle of his life."

Of Hunt's work as an architect Mr. Van Brunt shrewdly observes—and his point must carry consternation to many of those who have written on the subject of his art—that, as to his "professional achievements, an architect in the presence of architects cannot indulge in criticisms with the freedom and confidence of judgment which are displayed by those without professional responsibilities and conviction. We are all of us too deeply committed by practice, too deeply engrossed in the evolution of our ideals, to judge them without sympathy too warm for truth, or, perhaps, without bias too strong for justice." These indeed are wise words, and express at once the feelings of architects towards critics in general and that uncertainty of unbiased opinion which is characteristic, not of architects alone, but of artists of every sort.

Mr. Van Brunt's tribute is beautiful and just; it is one of those rare studies of which it can be truly said that here is the right man with the right subject. Yet we may be sure that its author would more gladly have undertaken any other task that might have been assigned him than the sad duty of pronouncing a eulogy upon his life-long friend.

Modern Building Design.

THAT any sort of modern design is possible by any people but the French and their over-enthusiastic followers in America would probably be a matter of astonishment to the latter gentlemen, who are striving so hard to turn the architectural thought of the United States into artificial and foreign channels. It is a basic principle with the followers of the School of Fine Arts in Paris that all their work—in which the forms of the long-dead Renaissance, or the still more anciently deceased buildings of Greece and Rome, are reproduced over and over again, or slightly modified to suit the new conditions that modern architecture unfeelingly thrusts into the building of our time—is modern in the best sense,— which doubtless means spelled with a capital M, instead of put in quotation marks.

To those who affect this sort of thing, a couple of lectures on "Modern Building

Design," recently delivered by Mr. W. R. Lethaby (*The Builder*, November 2 and 9), would not prove palatable reading; though every broad-minded man who will take the trouble to study them will find them not only highly interesting, but valuable and original. Mr. Lethaby sums up his chief points as follows:

(1) That all buildings carry their characters written on their fronts. (2) That students of architecture must learn to read these documents, questioning the right to exist of this or that so-called ornament or feature. (3) That this reading was proper criticism. (4) That there were only two purposes for a building,—service and delight,—and that instructed pleasure could be derived from a building only when it fulfilled certain positive conditions. (5) That there was now no general interest in building, because design was irrational and workmanship not pleasant. (6) That those, not architects, who had taken the trouble to think about building, said very plainly that they had no pleasure in us, the architects. (7) That there were only two methods of design possible,—the fresh experimental work of an artist thinking of terms in materials, or the re-combination on paper of the results of old artisan work. (8) That a small handiwork knowledge was so far better than none, but generally a fine work of art could only be produced by a workman. (9) That beauty was not a luxury, but was inseparably bound up with quality. (10) That we who were selfishly interested in beauty could not content ourselves with less than the endeavor to bring back beauty to all building, and thereby beautify the earth, and not desecrate it.

Surely these are reasonable propositions, and few will dispute them. But the author goes further than this. He deplores the study of ancient monuments for their detail and their application and revivification for modern needs, and would do away with the use of such time-honored and consecrated details as the egg-and-dart ornament, and other devices whose employment, we are constantly told by a number of well-intentioned individuals, is very modern indeed. Perhaps we cannot get rid of that ornament all at once; and certainly in its own place it is a very proper and beautiful thing; but at least we can put our students to better work than studying old buildings simply to use them over again! Mr. Lethaby urges that the construction of ancient buildings should be studied,—though it is hard to see how this would be profitable to modern architects, since modern construction is much more complex than anything in the past. Rather than this, it is the spirit of ancient art we need,—neither its forms or its construction, but the spirit that made it beautiful and great. This once understood, we need have no fear for the progress of modern art; nor need we then have a particular sect of architects who affect to call themselves "Moderns."

A Professor on Architecture.

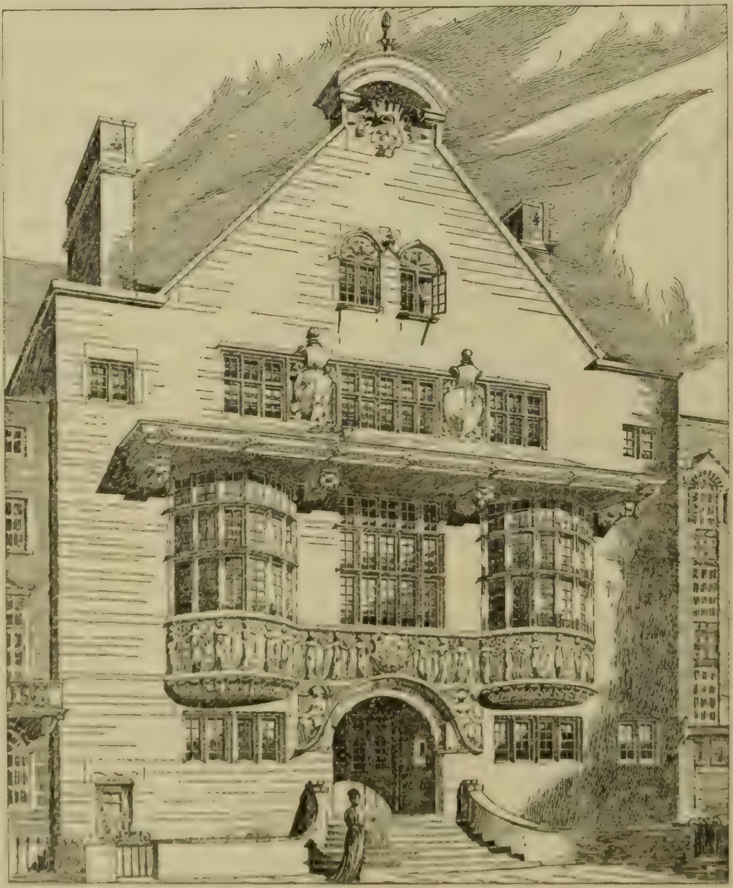
PROFESSOR ALBERT L. BROCKWAY contributes a paper entitled "Architecture from the Architect's Point of View" to the latest issue of the *Architectural Review*. He regrets the unnecessary difference between the public conception of architecture and that of the serious architect. The public expects an infinite resource of utilitarian knowledge, and profound familiarity with construction and materials. These are not unimportant to the architect, but architecture has a trinity resulting in harmony and unity, made up of plan, proportion, and profile. For these the architect sees practically no standards for the public at large upon which to base a judgment of his efforts. The vital part of any composition is embodied in and evolved from the plan. The proportions of the exterior are more or less dependent upon it. It is almost a truism that, having a good floor-plan conceived and well studied out, a good elevation almost necessarily follows.

These, and other propositions of a similar kind, are argued at considerable length, illustrations of the positions defended being made by the help of École drawings and unsuccessful competitions, all representing buildings not built or not intended to be built. The article represents, therefore, the views of the so-called École men in this country, though the author, from his title, evidently wishes to speak for the whole profession of architecture. He does not suggest that utility may enter into architectural design, nor does he touch upon the relationship between the positions he takes and the small and often unimportant buildings that make up the bulk of the practise of the modern architect. Still, everyone must agree with the professor in his instance of art in the floor-plan, though few will go as far as he does in maintaining that an artistic elevation is almost certain to follow from an artistic plan. That it is more likely to follow is reasonable enough, but the work of the students in the great French school, as the professor implies, is sufficient testimony to the unsafeness of so broad a proposition; since he admits that, while the floor-plan is often all that could be desired, the elevation is frequently unsatisfactory. It is true, also, that the public in general do not understand a plan or its value. But why should they be made to understand a theoretical plan, or be forced to study the plans of unbuildable and unbuilt structures?

It is impossible for any profession to harmonize its standards with the ideas of the general public, because even educated laymen are destitute of the particular knowledge requisite to judge such standards.

Illustrations of the Month.

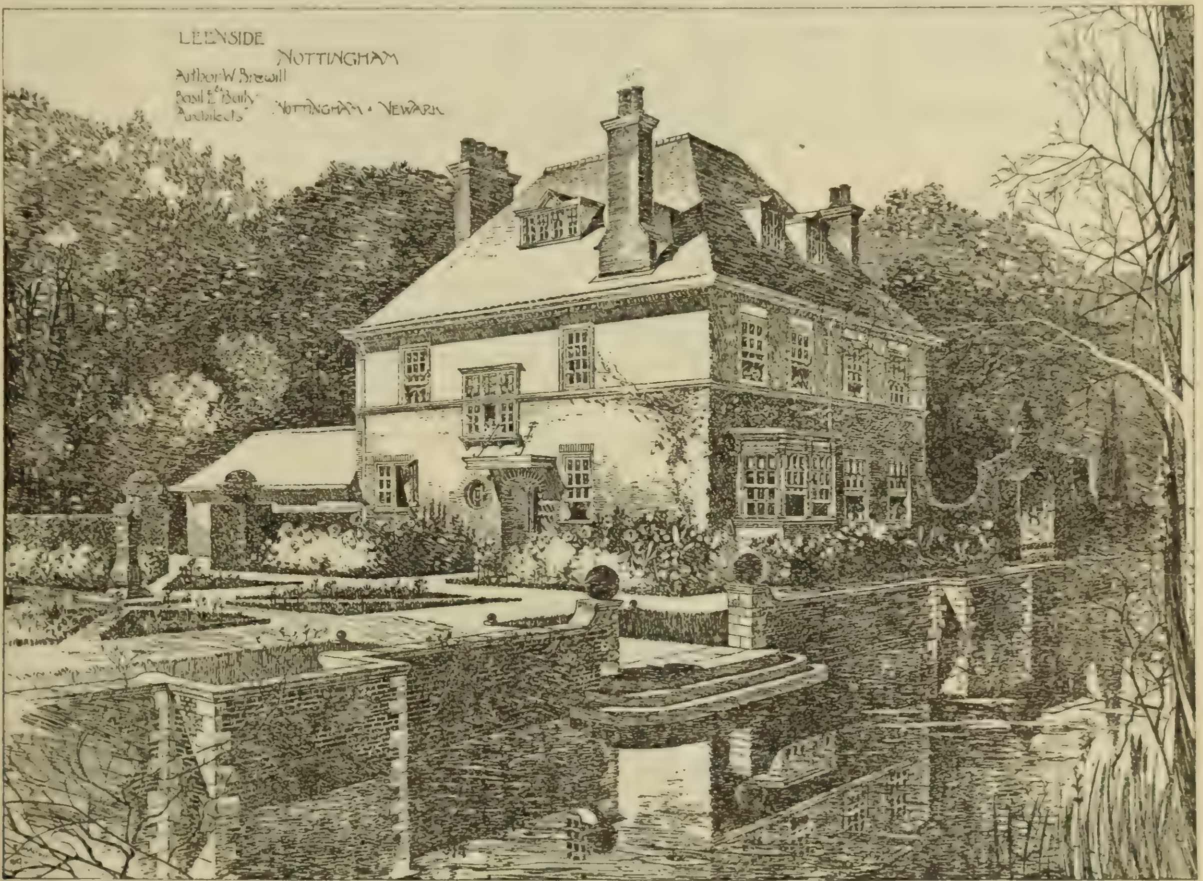
THE most notable drawings published in November were those of the second competition for the Minnesota State capitol at St. Paul, of which the winning design is commented on below. The *American Architect* continues its notable series of Urban Club Houses, with beautiful plates illustrating clubs in Philadelphia and Pittsburg. This series surely deserves preservation in collected form, and promises to be the most complete collection of photographs and drawings brought together by any American architectural journal on one subject. In commercial buildings the month brought out little new or important. The *Inland Architect* published a photograph of the Marquette building, Chicago,—a plain, straightforward design, entirely suitable to commercial necessities. It is a pity its authors should have introduced intermediate stories between the base and the superstructure, and again between the latter and the frieze, *à la* New York. *Architecture and Building* published photographs of the Presbyterian building, New York,—a design of much merit and simplicity, but with a basement too high for the superstructure and a gabled story above the cornice which has not the same value in perspective that it had in elevation. The same paper also gave a reproduction of a wash drawing of the new Bowling Green offices on lower Broadway, New York, accompanied with a quite astonishing essay on the "Hellenistic Renaissance," which,



DESIGN FOR PUBLIC LIBRARY. PERCY E. NEWTON.

we are informed, is here applied for the first time to a high building. The illustration is not a good one, and it is, therefore, not quite just to its authors to criticise their performance from it. There is, however, a heaviness in it that is not pleasant, and the value of the vertical lines of the main portion is impaired by the structure apparently built on top of the lower building, though really an integral part of the whole.

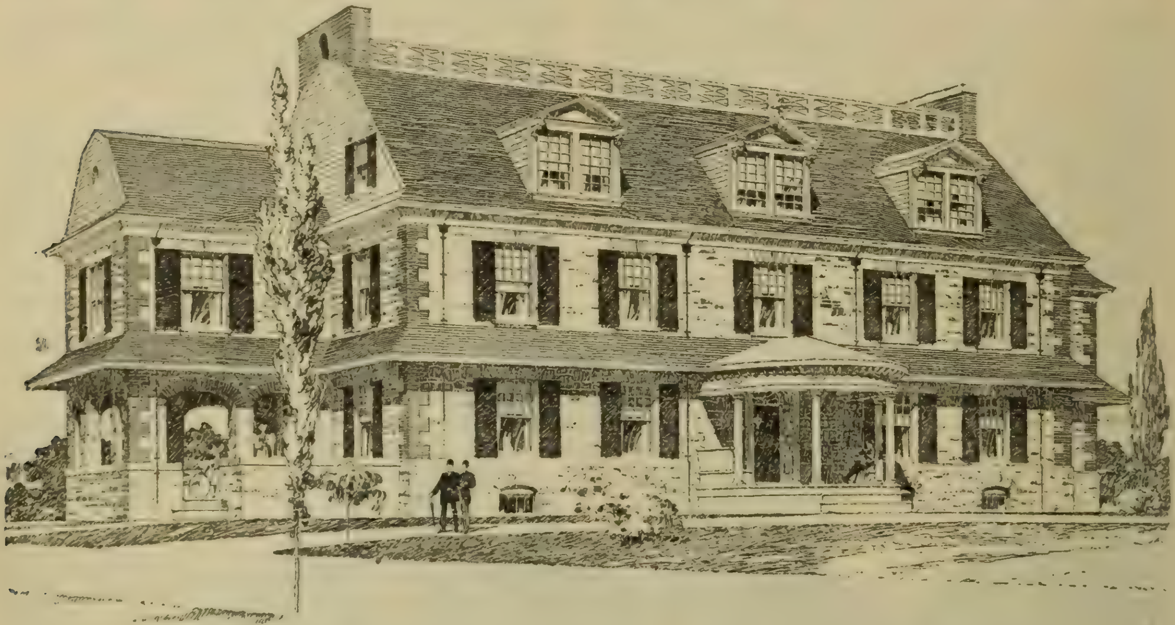
In houses, both country and city, there is little of note. The *American Architect* continued its illustrations of Mr. Hoagland's place at Seabright, and, among less important dwellings, illustrated a house for Mr. Newbold at Laverock, Penn., which is a good sort of thing not to do. The design is simple enough, and quite devoid of eccentricity, but the architects at the end of this century do not need to affect the style of the buildings of the end of the last. An agreeable contrast to this American house is "Leenside," at Nottingham, published in *The Builder*. This is a very English design, excellent, quiet, and seemingly just the right sort of house for the formal garden that surrounds it and the river close beside it. A charming little house at Boonton, N. J., appeared in *Architecture and Building*.



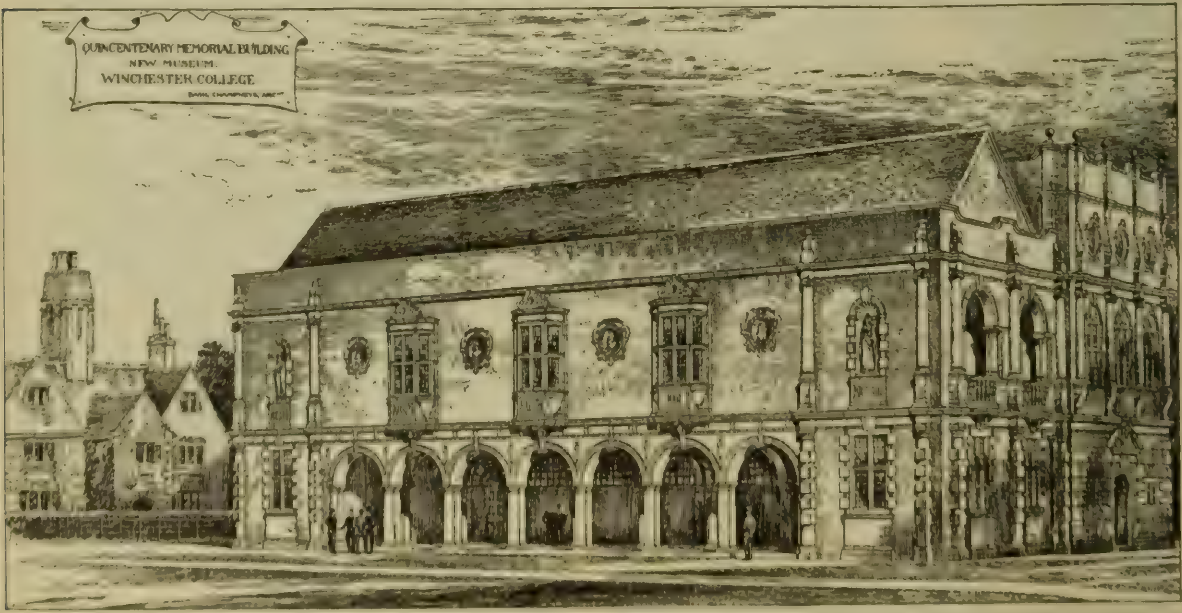
LEENSIDE, NOTTINGHAM. BREWILL & BAILEY, ARCHITECTS.

The English papers are not up to their usual mark in the interest of their pictures. The most notable single drawing is the general view of the new design for Christ's Hospital Schools, noted below. *The Builder* published, in addition, a charming design for a public library by Mr. Newton, and the selected design for Llandudno municipal buildings,—the latter very English,—and both interesting examples of recent English architecture, and for that very reason not proper subjects for American reproduction. The design of Mr. Champneys for the Memorial Building at Winchester College will be of interest to the readers of Mr. Statham's notable article on English architecture in the November number of the MAGAZINE.

The design for the City Assembly Rooms



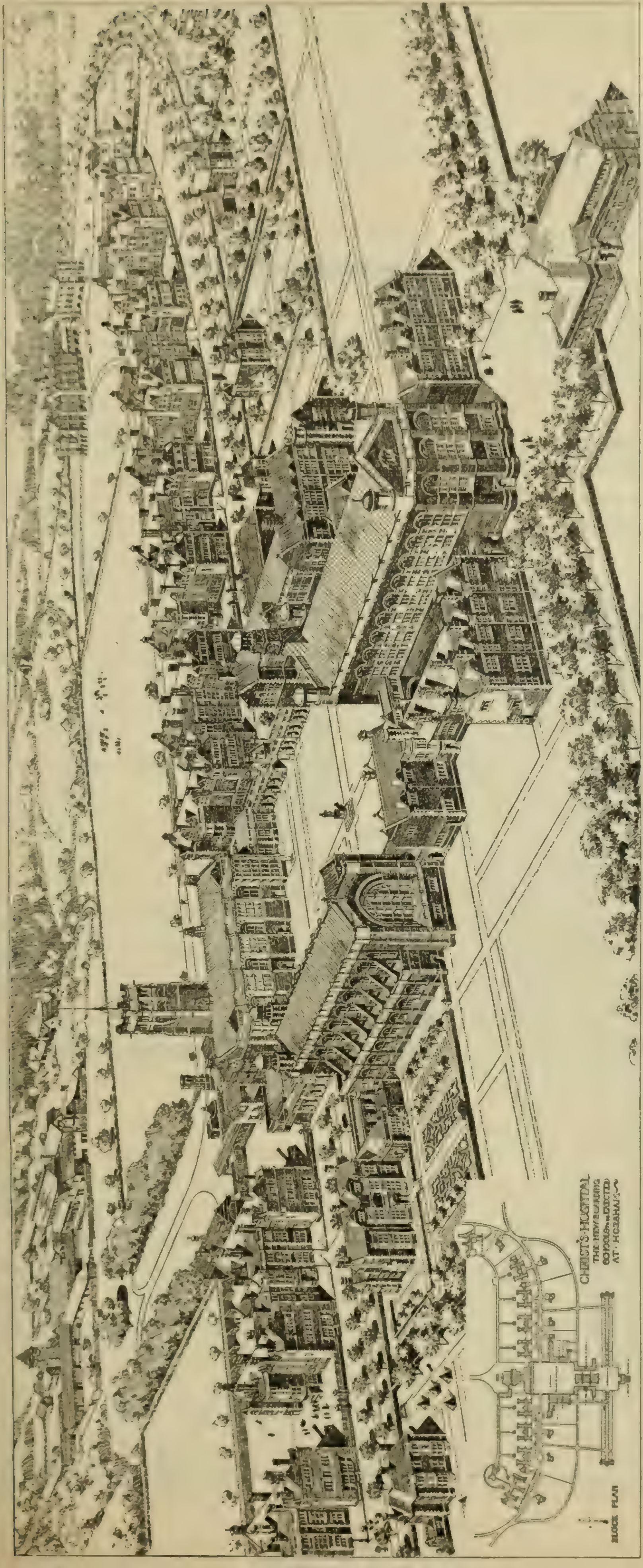
MR. NEWBOLD'S COUNTRY HOUSE, LAVEROCK, PA. GEO. T. PEARSON, ARCHITECT.



QUINCENTENARY MEMORIAL BUILDING. NEW MUSEUM BUILDING, WINCHESTER COLLEGE.
BASIL CHAMPNEYS, ARCHITECT.

in Birmingham, in *The Architect*, is as bad a design as has been published for some time. The beautiful church of All Saints, Ashmont, Boston, Mass., printed in the *American Architect*, is easily the most notable illustration of church architecture of the month. The very elaborate illustration of the work of Richard Morris Hunt, published in the new number of the *Architectural Record*, is referred to above.

THE general view of the design for the new Christ's Church Hospital Schools, Horsham, England (*The Builder*, Nov. 2), illustrates one of the most notable recent English competitions for a great public building. The question was decided more than a year since, and the award made to Messrs. Ashton Webb and Ingress Bell, who have come into unusual prominence within the last few years by reason of their successes in a number of important competitions. Unfortunately for the architects and for the institution some difficulties concerning funds have postponed the beginning of this work.



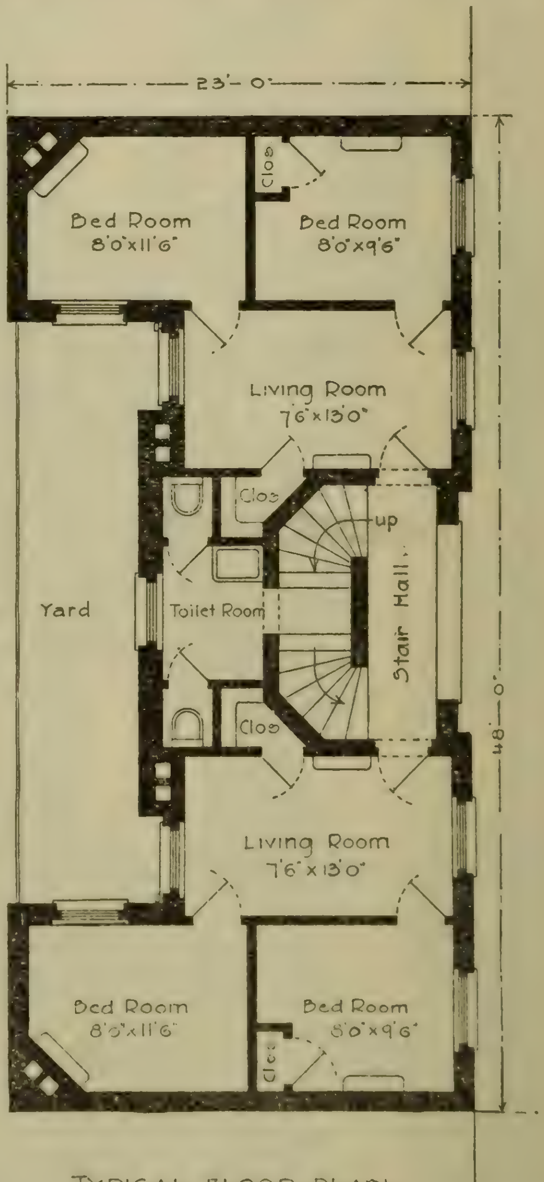
GENERAL VIEW OF DESIGN FOR THE NEW CHRIST'S HOSPITAL SCHOOLS. MESSRS. ASTON WEBB & INGRESS BELL, ARCHITECTS.

The competition attracted attention by reason of the eminence of the architects who took part in it and from the great size and difficulty of the problem. The authors of the successful design devised an exceedingly clever plan, with the general rooms, dining-hall, school-rooms, and administrative and other buildings in the centre, and isolated halls or houses stretching away on either side of the central group, the whole forming a vast segment flattened in the centre. The design is thoroughly collegiate and as thoroughly English, and picturesquely varied yet the different parts are so skilfully welded together as to form an entirely homogeneous and united work. Its chief merit is the plan, which was markedly superior to any other submitted in the competition, and which, in the working out, has been treated in a highly original, but traditional, manner. The design is interesting also as offering a problem quite different from those which come before American architects, the purpose of the buildings being as British as their art. For a great educational establishment it is doubtful if all England contains so important a group as this will be when built,—surely none so modern.

THE *American Architect* (November 2) reproduces from the May number of the *Moniteur des Architectes* a view of a design submitted by M. Esnault Pelterir for a Palais aux Champs-Élysées in the first competition for the Paris Exhibition of 1900. It is a grandiose structure in two symmetrical parts, separated in the center, but connected by a wide-spreading dome. The conception is novel, and the plan, which provides for the opening of two new avenues and a vista from the Palais de l'Élysée through the central dome, is superbly worked out. The elevation, of which only fragmentary parts are shown in the view printed in the *American Architect*, provides for a basement, plainly treated with large round-headed windows and doors, and a main story, in which a series of similar windows are carried behind a colonnade of coupled columns, broken, at intervals, by decorated solid piers. Adjoining the dome is a decorated pavilion, which is repeated at the further extremity of the straight front, beyond which the building is continued in a curve, with an ornamental pavilion in the axis and a semi-domed roof of glass, which closes the high semi-circular roof of the main part.

The building is apparently well suited for exhibition purposes, being of a sufficiently ornamental architecture to serve as the home of beautiful things. The most striking feature is the vast dome connecting the two parts. Of practical utility this has none at all, for, though it joins the two parts of the building, it does so at such a height as to afford little shelter in stormy weather. As an ornamental device, it certainly has the merit of novelty, while its juncture with the roofs of the adjoining parts gives a unity to the upper part of the building that is necessarily absent from the lower. The dome is of iron and glass and the buildings of stone; were it not for this fact, we might be tempted to believe that this was a Parisian amplification of a design for an exhibition building in Cook county, Illinois. The scheme is more attractive in plan than in elevation.

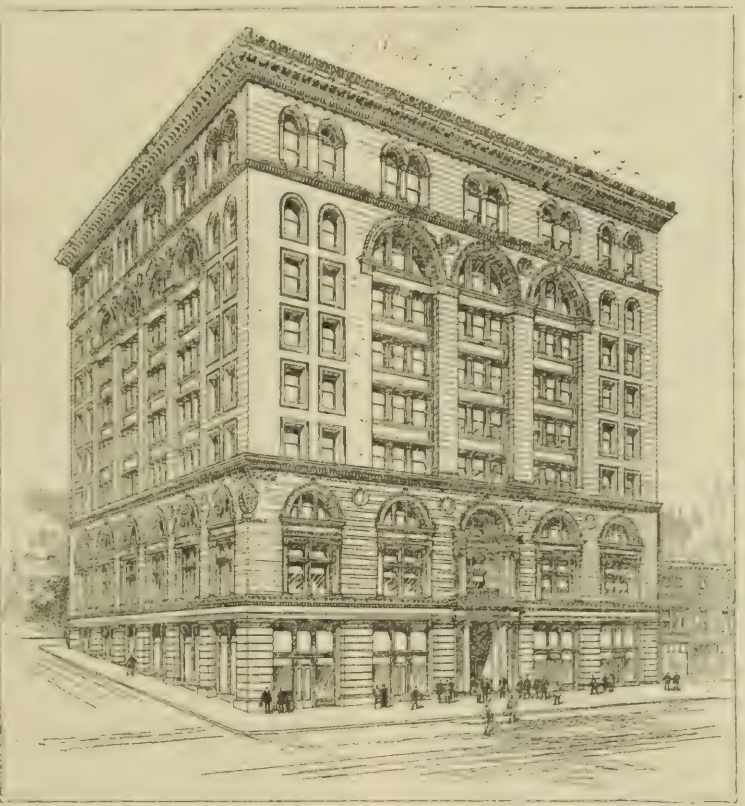
TENEMENT houses are so rare in Philadelphia, and such very bad things in themselves, that their erection in the "city of homes" must be deplored by every one interested in the housing of the poor. Some time since, the "Benevolent Building Association" was organized in that city to buy up and remove bad buildings used by the poor, and replace them by better buildings in which the rent would not be higher. Considering the extremely low price at which small houses of good description can be had in Philadelphia, this experiment would seem to be a hazardous one. The *American Architect* (Nov. 30) publishes a view and plan of one of the new buildings recently erected by Wilson Brothers & Co. of that city. The plan, which is reproduced herewith, is interesting in the contrast it offers to



TYPICAL FLOOR PLAN

the typical New York tenement house. In New York such a building is long and narrow, with the narrow front on the street. In the Philadelphia example the broad front is on the street, and a much more sanitary and convenient plan is possible.

THE State Mutual Life Assurance Company building, Worcester, Mass., is a large square structure (*American Architect*, Nov. 2), nine stories high and open on three sides to as many streets. It is in the Renaissance style, and is a sufficiently correct application of that style to the purposes of commercial design. That is to say, if we must use the Renaissance for modern office-buildings, the way to do so is illustrated in this edifice, where it is employed in the detail, for the window frames, cornices, entrances, and the like. The architects have wisely discarded the use of ornamental columns and pilasters, and designed the upper part of their building with commendable sobriety. The richest stage—and here the ornament is confined to the monumental windows—is the second floor, which contains the offices of the company, and which is, therefore, the main floor. The detail is scarcely discernible in the general perspective, but is shown in some smaller drawings, published at the same time, to be entirely satisfactory both in quantity and in application.



STATE MUTUAL-LIFE ASSURANCE COMPANY BUILDING, WORCESTER, MASS. PEABODY & STEARNS, ARCHITECTS.

Yet, as a whole, this design is not quite satisfactory. That it will seem better in the actual building than in the drawing may safely be counted on, for the shortcomings of the earlier sketch, in the hands of such competent architects as its authors, will certainly be removed with erection. The design suffers from proportions not altogether happy. It is not quite high enough for its width and breadth, and the horizontal divisions are not pleasing. The second story really includes two stories' and, while it may have been necessary to emphasize the situation of the company's offices, the treatment followed is not good. In the design these two stories form but one, with an apparent height greater than the other portions permit.

TWO competitions have now been held for the purpose of securing a design for a new State capitol at St. Paul, Minn. The second one has just been concluded, and a number of the designs, successful and otherwise, have been published in the architectural papers (*Inland Architect*, Nov., the five premiated designs; others in the *American Architect*, Nov. 16 and 30). The award in this competition was made by Mr. E. M. Wheelwright, of Boston, whose recommendation that the design of Mr. Cass Gilbert be chosen has been accepted by the committee.

Of the designs published, that by Mr. Gilbert is undoubtedly the best. It is dignified and quiet, yet sufficiently monumental to be satisfactory for its purpose as the capitol of a great and growing State. In this respect it offers a considerable contrast with some of the other designs, which show that fussiness and over-elaborateness of effect which so many architects regard as part of the natural character of the Renaissance. For it need hardly be said that all the designs thus far published are in this style of architecture; and, indeed, in a competition to be decided by an architectural expert, any other style would have been out of place and an act of needless folly on the part of the designer. Thus much, at least, the Frenchifying tendency of the Beaux Arts men has accomplished, and it would be interesting to know if they regard the Minnesota competition as illustrating their ideal and satisfactory to their ideas.

The accepted design shows a rather long building, whose main front is broken only by the projecting center and very shallow wall-pavilions at each end. A two-story basement, which in the centre is provided with a broad flight of steps to its upper story, supports the main wall, divided by Corinthian pilasters, between which are large framed windows with smaller ones above them. The center is treated as a pavilion, with a colonnade of coupled columns between solid ends. This carries a paneled attic with groups of sculpture above, while the wing walls are capped by a cornice and balustrade. Over the center rises the dome, a large and dignified structure, whose drum between the windows is divided by piers faced with coupled columns. It suffers somewhat from its isolation. In the perspective sketch it rises directly from the center of the roof without the assistance of a single feature that leads up to it. This, however, is a minor misfortune that is more than offset by the quiet restraint in the whole design, to which, unquestionably, much of its success is due.

Index to Illustrations.

Apartment Houses. Tenement House Philadelphia (view and plan), by Wilson Bros. & Co., Amer. Archt., Nov. 30.—The Bolkenhayn, New York, by A. Zucker, Archt. and Build., Nov. 2. —Nelda Apartment Building, Chicago, In. Archt, Nov.—Apartment Building, Chicago, by Pond & Pond, ibid.

Churches. Crematorium and Chapel (elevations, plan, section), by Tarbolton & Tugwell. Amer. Archt., Nov. 23.—All Saints P. E. Church, Ashmont, Boston, by Crane, Wentworth & Goodhue, ibid, Nov. 30.—Synagogue, N. Chicago Hebrew Congregation, Chicago, ibid,—Redcliffe Parish Room, Bristol, by H. C. M. Hirst, Archt., Nov. 15.—Sketch for P. E. Church, Lincoln, Ill., by E. S. Somers, Archt. and Build., Nov. 16.—Unitarian Church, Manchester, Mass., by Coolidge & Wright, Brickbuilder, Nov.—Plashet Park Congregational Church, by P. M. Horder, Brit. Archt., Nov. 1.—Proposed Church, Burton-on-the-Wolds (elevation, plan), by A. M. Poynter, ibid, Nov. 8. —Interior, Church of Most Holy Redeemer, Chelsea (original design), Builder, Nov. 16.—St. Andrews, Wilesden, by J. Brooks & Son, ibid, Nov. 2.—Country Church, by C. J. Gibson, Canadian Archt., Nov.—St. John's Church, Norway, by same, ibid.

Club Houses. University Club House, Philadelphia (interior), by Wilson Eyre, Jr., Amer. Archt., Nov. 2.—Duquesne Club House, Pittsburgh, Pa., by Longfellow, Alden and Harlow, ibid, Nov. 23.—Mercantile Club-House, Philadelphia, by Baker & Dallett, ibid, Nov. 30.—Kenwood Club, Chicago, by Belton and Fisher, and C. S. Frost, In. Archt., Nov.

Commercial Buildings. State Mutual Life Assurance Company Building, Worcester, Mass. (views, plans, interior), by Peabody and Stearns, Amer. Archt., Nov. 2.—Entrance to Restaurant, Paris, by Lecq, ibid, Nov. 9.—Detail in Aldersgate, London, by Romaine, Walker and Tanner, ibid, Nov. 30.—No. 18 Great Marlborough St., by P. Stone, Archt., Nov. 8.—Bank, Bolton, Eng., by Bradshaw and Gass, ibid, Nov. 22.—Bowling Green Offices, New York, by W. and G. Audsley, Archt. and Build., Nov. 9.—Presbyterian Building, N. Y., by J. B. Baker, ibid, Nov. 16.—Chapin Stores, Buffalo, N. Y., by E. A. Kent, ibid, Nov. 23.—Office and Store Building, Boston, by Winslow and Wethrell, Brickbuilder, Nov.—Royal Insurance Company's Building, Glasgow, by J. Honeyman and Keppie, Brit. Archt., Nov. 15.—Halifax Bank (second prize), by J. B. Mitchell Withers, Builder, Nov. 2.—Dominion House, Fenchurch St., by D. Joseph, ibid, Nov. 9.—West India House, Leadenhall St., E. C., by same, ibid.—Design for Terrace at Stoke Newington, by Booth and Anderson, ibid, Nov. 16.—Wholesale Store Building, Waterloo, Iowa, by Josselyn & Taylor, In. Archt., Nov.—Marquette Building, Chicago, by Holabird & Roche, ibid.

Engine Houses. At Hartford, Ct., by F. M. Comstock, Archt. and Build., Nov. 9.—At Hackensack, N. J., by W. A. Lambert, ibid.

Historical and Miscellaneous. Stair to Church, Brindlach, Amer. Archt., Nov. 9.—Pulpit in Schlosskirche, Wittenberg, ibid.—Sketches by J. W. Case, ibid.—Old Gov. Brooks' House, Medford, Mass. (views, plan), ibid, Nov. 23.—Gray's Inn Chapel, London (interior), ibid, Nov. 30.—St. Georges de Boucherville, Archt., Nov. 8, 15, 22.—Window in Municipia, Monza (elevation, plan), Brickbuilder, Nov.—Central Balcony, Tremont Temple, Boston, Mass., by Blackall and Newton, ibid.—St. Martins, Wareham (views, sections, plan), by C. R. Macintosh, Brit. Archt., Nov. 8.—Doorway at Rome, Ironwork at Siena, sketches by H. S. East, ibid, Nov. 15.—Choir Screen, St. David's Cathredal, drawn by T. G. Jackson, Builder, Nov. 23.—Dutch Windmill, Truesdell, Wis., drawn by J. T. W. Jennings, Inland Archt., Nov.

Hospitals. Free Hospital for Women, Brookline, Mass., by Shaw & Hunnewell, Amer. Archt., Nov. 9.

Houses, City. Of late W. Burgess, Kensington, London, by himself, Archt., Nov. 8.—New Picture Gallery for Sir Frederick Leighton, London (interior), by G. Aitchison, Builder, Nov. 9. —For W. D. Marsh, Evanston, Ill., by J. T. W. Jennings, Inland Archt., Nov.—For P. D. Armour, Jr., Chicago, by F. W. Perkins, ibid—Houses in Chicago, by Pond and Pond, ibid,—For H. Thomson, Chicago, by H. Shaw, ibid.—House in Chicago, by Shepley, Rutan and Coolidge, ibid.

Houses, Country. For J. C. Hoagland, Seabright, N. J. (gateway, interiors), by Shepley, Rutan and Coolidge, Amer. Archt., Nov. 16.—For Mr. Newbold, Laverock, Pa., by G. T. Pearson, ibid.—Fieldstone Terrace, Brookline, Mass., ibid. —"St. Keverne," Harrow on the Hill, by A. Mitchell, ibid, Nov. 23.—For J. D. Safford, Springfield, Mass., by E. J. Parlett, ibid, Nov. 30.—For Mrs. Frederick Power, near Coleshill, by E. C. Bewley, Archt., Nov. 15.—Bedston Court, Birkenhead, by Grayson & Ould, ibid, Nov. 22. —Country Residence (view, interiors, plan), by E. G. W. Dietrich, Archt. and Build., Nov. 2.—For Mr. E. P. Smith, Greens Farms, Ct., by Jardine, Kent, and Jardine, ibid, Nov. 16.—For W. S. Johnson, by E. G. W. Dietrich, ibid, Nov. 30. —At Boonton, N. J., by Boring & Tilton, ibid.—Sketch for Suburban Home (with plan), by I. C. Eagles, ibid, Nov. 9.—At Woodside Park, N. Y., by W. T. Walker, Builder, Nov. 2.—Entrance Front of same, ibid.—"Leenside," Nottingham, by Brewill and Baily, ibid.—At Sutton Coldfield, by E. Newton, ibid, Nov. 23.—For Judge Spinks, Swan Lake, Okanagan, B. C. (elevations, plans), by R. M. Fripp, Canadian Archt., Nov.—For Arthur Thompson, Glen Road, Rosdale, ibid.

Libraries. Proposed Fisk Memorial Library, Wrentham, Mass., by D. H. Woodbury, Amer. Archt., Nov. 9.—Proposed Public Library, Fall River, Mass., by N. C. Smith, ibid.—Accepted Design, West Ham Technical Institute and Library (view and plans), by Gibson and Russell, ibid, Nov. 2.—Second and Third premiated design for same, ibid, Nov. 16.—Public Library, by P. E. Newton, Builder, Nov. 9.

Minnesota State Capital, Alternative Design, First Competition, by W. B. Dunnell Amer. Archt., Nov. 16.—Design, with plans, First Competition, by H. T. E. Wendell and J. J. Humphreys, ibid, Nov. 30.—Accepted Design, Second Competition (view & floor plans), by C. Gilbert, In. Archt., Nov.—Second Prize, by G. R. Mann, ibid.—Third Prize, by Traphagen & Fitzpatrick and E. P. Bassford, ibid.—Fourth Prize, by C. H. Johnston, ibid.—Fifth Prize, by H. W. Jones, ibid.

Monuments. Sun Dial, Walton House, by Brewill and Baily, Amer. Archt., Nov. 9.—To Achille Testoin, Lille, France, by Bonnier & Cordonnier, ibid.—John Hooper, Memorial Fountain, Brooklyn, by G. M. Huss, Archt. and Build., Nov. 2.—Washington Memorial Arch, Washington Square, N. Y., by McKim, Meade and White, ibid, Nov. 23.—Competitive Design for Chattanooga Battle Field, by E. Roth, ibid, Nov. 30.

Municipal Buildings. Public Baths, Washhouses & Municipal Offices, Deptford, by T. Dinwiddy, Amer. Archt., Nov. 9.—Llandunno Municipal Buildings (accepted design), by T. B. Silcock, Builder, Nov. 9.

Museums. Government Museum, Bangalore, Amer. Archt., Nov. 2.—Palais aux Champs Élysées, Paris, by Esnault Pelterie, ibid.—Quincentenary Memorial Building, New Museum, Winchester College, by B. Champneys, Builder, Nov. 16.—Glasgow Art Galleries, Competition Design, by J. Lindsay, ibid, Nov. 23.

Public Buildings. The Mayo Hall, Bangalore, Amer. Archt., Nov. 2.—Springfield (Mass.), City Market, by Gardner, Pyne & Gardner, ibid, Nov. 9.—City Assembly Rooms, Birmingham, Eng. (view and interior), by E. Nicol & Goodman, Archt., Nov. 15.

Schools. New High School, Somerville, Mass., by Hartnell, Richardson and Driver, Amer. Arch., Nov. 9.—Door, Faculté des Sciences, Sorbonne, Paris, by Nénot, ibid.—High School, Emporia, Kansas, by H. W. Jones, ibid, Nov. 23.—Free Public Library and Manual Training School, Hoboken, N. J., by J. Ross, ibid, also, Nov. 16. —District School, Bayport, N. Y., by C. K. Birdsall, Archt. and Build., Nov. 9.—Trinity School, N. Y., by C. C. Haight, ibid, Nov. 30.—General View of Design for new Christ's Hospital Schools, Horsham, Eng., by Webb and Bell, Builder, Nov. 2.

Students' Work. Sanitarium Hotel, Thesis Design, by E. J. Moeller, Archt. & Build., Nov. 16.—Theatre for Cantatas, by C. A. Fullerton & W. M. MacCafferty, ibid, Nov. 23.—Garden Pavilion, R. I. B. A. Tite Prize, by W. T. Connor, Brit. Archt., Nov. 1.—Picture Gallery R. I. B. A. Soane Competition, by G. L. Morris, ibid, Nov. 8.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Architecture and Building in the American, English and British Colonial Technical Journals—See Introductory.

*2473. The Value of Good Architecture in Cities. Barr Ferree (Comparing the architecur al taste of America and Europe, and pointing out the commercial and esthetic advantages accruing to a people who practice good architecture). Eng Mag–Jan. 4300 w.

*2479. Some Danish Churches. Ill. H. Rose (An account of a tourist's trip with brief architectural studies). Builder–Nov. 2. 2500 w.

*2480. Modern Building Designs. W. R. Lethaby (An abridged report of a lecture given at the Central Art Department of the Technical Education Board, London). Builder–Nov. 2. 2400 w.

*2551. The works of the Late Richard M. Hunt. Ill. Montgomery Schuyler (A review of the career and works of this distinguished architect, instructive and written in pleasing style. It is copiously illustrated by views of "The Breakers," "Ochre Court," "Belcourt," "The Marble House," and other notable places and buildings). Arch Rec–Oct-Dec. 19000 w.

2578. The Effect of Fire on a Partially Fireproofed Building (Showing that when the beams are not entirely covered by fire-proofing material, the structure is not properly fireproof, as was shown by the beams giving way in the case of the Manhattan Bank Building in the late New York fire). Eng News–Nov. 14. 350 w.

†2595. The Union of Building Trades' Schools with Schools of Architectural Design. Robert D. Andrews (Synopsis of a paper read at the 9th An. Con. of the Nat. Assn. of Builders, at Baltimore. Outlining the method by which such union may be made valuable and explaining why it seems desirable). In Arch–Nov. 3300 w.

*2602. Modern Building Designs. Positive Conditions. Mr. Lethaby, with editorial (Abstract of third lecture, with short discussion). Builder–Nov. 9. 5500 w.

*2608. Inaugural Address of F. C. Penrose before the Royal Institute of British Architects (Touching upon the relation of architects to the public; building surveyors under local authorities; competitions in general; competitions and their promoters; development of architectural education; the metrical system of measurement, &c). Arch, Lond–Nov. 8. 9000 w.

*2731. Pompeii. Talfourd Ely (An address, illustrated by lantern slides, given before the Architectural Asso. Descriptive of this city, its buildings, works of art, &c). Arch, Lond–Rev. Nov. 15. 4000 w.

*2732. Domes (A consideration of noted domes, such as St. Sophia, St. Peter's, &c). Arch, Lond–Nov. 15. 3000 w.

*2733. Apprenticeship (Editorial on an article in the *London Technical Education Gazette* which was a summary of results of a systematic inquiry into the state of apprenticeship in the various trades of London, and views of various employers regarding the possibility of developing the system in the future. The article deals only with the building trades). Builder–Nov. 16. 2800 w.

*2734. An American Architect on Renaissance Architecture (An extract from an article by R. S. Peabody in the *Atlantic Monthly*, showing how the architecture of this period affects the mind of an eminent architect). Builder–Nov. 16. 1100 w.

*2735. Architectural Education in the States (A report presented at the An. Con. of Amer. Inst. of Arch., by the Committee on Education). Brit Arch–Nov. 15. 1800 w.

2840. Engine-House for Fire Department, New York City (Detailed illustrated description of building). Eng Rec–Nov. 30. 900 w.

2881. Specifications from an Architect's Point of View (A paper read before the Arch. Assn. by B. F. Fletcher in the absence of Mr. Pinks, the author. Critical examination of the specification as it is; consideration of the necessity of specifications; and suggestions for their abolition as separate documents in a contract). Arch & Build–Nov. 30. 4000 w.

*2903. Old Architecture in Greater London (Descriptive of interesting English architecture in and near London). Ill Car & Build–Nov. 22. 2000 w.

*2904. Imitating Woods (Directions for imitating oak, mahogany, satinwood, walnut, rosewood, etc). Ill Car & Build–Nov. 22. 2100 w.

2905. Study of the History of Architecture (Extract from a paper describing the methods by which the history of architecture is taught at Columbia College). Am Arch–Nov. 30. 2800 w.

*2906. Building and Sanitary Construction. Banister Fletcher (Abstract of the third lecture of a series being given at Carpenter's Hall to students and clerks of works). Arch, Lond–Nov. 22. 2500 w.

†2908. The Sculptured Columns of the Temple of Diana at Ephesus. Alex. S. Murray (Paper read before the Royal Inst. of British Archs., with illustrations and discussion). Jour of the Roy Inst of Brit Arch–Nov. 21. 9000 w.

†2936 Topical Discussion—Durability of Iron in Modern Building Construction (Processes, investigations, experiences and suggestions. (Pro Eng's Club of Phila. July–Oct. 9500 w.

*2954. The Fire Hazard in Mills. James Goldie (Principles of fire-proof and of slow-burning construction, applied to flour-mills and the supply of means for extinguishing fires in this class of structures). Am Miller–Dec. 1900 w.

†2955. Durbar Hall and Recreation Rooms for His Highness, Sawai Mahindra, Maharaja, Sir Pretap Singhjee, Sar-Amad Rajgan of Bundelkhand, K. C. I. E. (Illustrated description). Ind Engng–Nov. 2. 900 w.

*2976. The Municipal Control of Buildings. G. B. Longstaff (The necessity discussed, and the buildings considered from the points of view of stability, fire, health, position and mutual relations, convenience, and beauty. Paper read before the Arch. Assn. London, with discussion). Builder–Nov. 30. 11000 w.

*3000. Architectural Competitions and Public Buildings. William Henman (The concluding portion of a presidential address at a meeting of the Birmingham Arch. Assn., with editorial). Brit Arch–Nov. 29. 2400 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Water Power, Its Generation and Transmission.

In a paper read before the American Society of Mechanical Engineers by Samuel Webber the question of reutilizing the power stored in water supplies is ably discussed. *The Iron Age* (Dec. 5) contains the paper, from which we abstract as follows:

"An annual rainfall of 42 in. is equal to 267,409 cu. ft. per day on a sq. mile, or 3.09 cu. ft. per second; and, if we take one-third of this, or 1 cu. ft. per second, from each sq. mile of drainage area, we arrive at the supply which can usually, by the aid of storage, be relied upon.

"The paper briefly dwells upon the development of the turbine wheel, and presents the following table as showing the difference in quantity of water used and power obtained by a number of wheels of nearly the same diameter, under the same head of 26 ft. beginning with the Boyden Fourneyron, and ending with the Victor:

Make of Turbine.	In. Diam.	Cu. ft. water per sec.	Horse-Power.
Boyden Fourneyron ..	36	22.95	55
Risdon..............	36	35 45	89
Risdon "L. C."......	36	48.27	121
Risdon "D. C.".....	36	80	199
Leffel, Standard......	35	40.45	96
Leffel, Special........	35	60	148
Tyler...............	36	40.7	95.8
Swain...............	36	58.2	140
Hunt, "Swain bucket"	36	48.8	121
Hunt, New Style.....	36	98	239.74
Leffel, "Samson"....	35	109.1	264
"Hercules".........	36	107 6	253.5
"Victor"...........	35	108 8	266

"This enormous difference in productive effect in wheels of the same diameter shows the great economy of the latter type of turbines, particularly as all the wheels above named have a proved efficiency of 80 per cent, and some of them have given more; such as 87 per cent. for the Risdon, tested by Edward Sawyer of Boston, at Crompton, R. I., and by the writer at the Centennial; 87 per cent. for the Hercules, tested by Professor Thurston; 84 per cent. for the Collins, by the same authority; 84 per cent., nearly, for the Swain, by Mr. Francis; 84 per cent. for the Geyelin and the Hunt, tested by the writer; and 88 per cent. for a 15 inch Victor, by the same, but this was so small a wheel that the test cannot be depended on.

"As showing the cost, we take the following in regard to the Concord Water Power Company, on the Merrimac river, at Concord, N. H. Here the power developed is at a minimum 3,300 h. p., on an average 5,000 h. p., from a fall of 22 ft. The wheels are Rodney Hunt turbines, set in pairs on horizontal shafts of 400 h. p. each. The cost has been as follows:

700 acres land, and flowage rights	$ 20,000
Dam and abutments................	141,015
Canal, 60 ft. wide..................	27,363
Head gates........................	16,675
Waste weir........................	5,220
Making an investment for water of..	$210,273

or $63.72 for the minimum amount of power, or $42.05 for the average amount of power. To this is to be added: pits and foundations put in for 2,000 h.-p., $15,000, or $7.50 per h. p.; wheels put in for 1,600 h. p., $12,225, or $7.66 per h. p., making a total, for the minimum flow of water, of $78.88 per h. p., and, for the average flow, of $57.75 per h. p. Now, if we base our calculation of cost on the minimum flow, and allow interest, 5 per cent., sinking fund, 2½ per cent., repairs, 1½ per cent., taxes, &c., 1 per cent., we get a total annual cost of 10 per cent., or $7.89 per h. p., to which add oil and attendance, 75 cents, making $8.64. As this power is to be transmitted, in part, at least, to Concord by electricity, the cost of such transmission, on which I do not assume to be authority, will have to be added to this. If, on the other hand, it is to be partially used near at hand, it is safe to say that the cost of transmission by shafts and belts would not increase to over$ 10 per h. p."

Union Pacific Railroad Bridge Specifications for 1895.

THESE standards are classed by George H. Pegram, chief engineer, under the heads of Dimensions, Loads, Forces, Details, Workmanship, Material, Painting, Erection, Inspection, and Drawings, the last five of which present no new features. Mr. Pegram, in *The Engineering News* (Nov. 16) writes: "You will note that I treat the live load in all cases as a uniform load, designed to include the effects of impact. This gives practically the same results as using the wheel loads in the old way, with a large saving in labor of computing stresses." The following extracts from the specifications include some of the most interesting and important features:

"The width, center to center of trusses, shall never be less than one-twentieth of the span length.

"Tower spans in trestles must not be more than 40 ft. long.

"Top chord panels shall not have a greater length than 1½ times the width between chord centers.

"Preference will be given to girders which have a greater depth than one-twelfth and trusses one-eighth the span length.

"One-third of the dead load shall be assumed as concentrated at the panel points of the unloaded chord.

"Unless otherwise specified, the heavy loading shall be used.

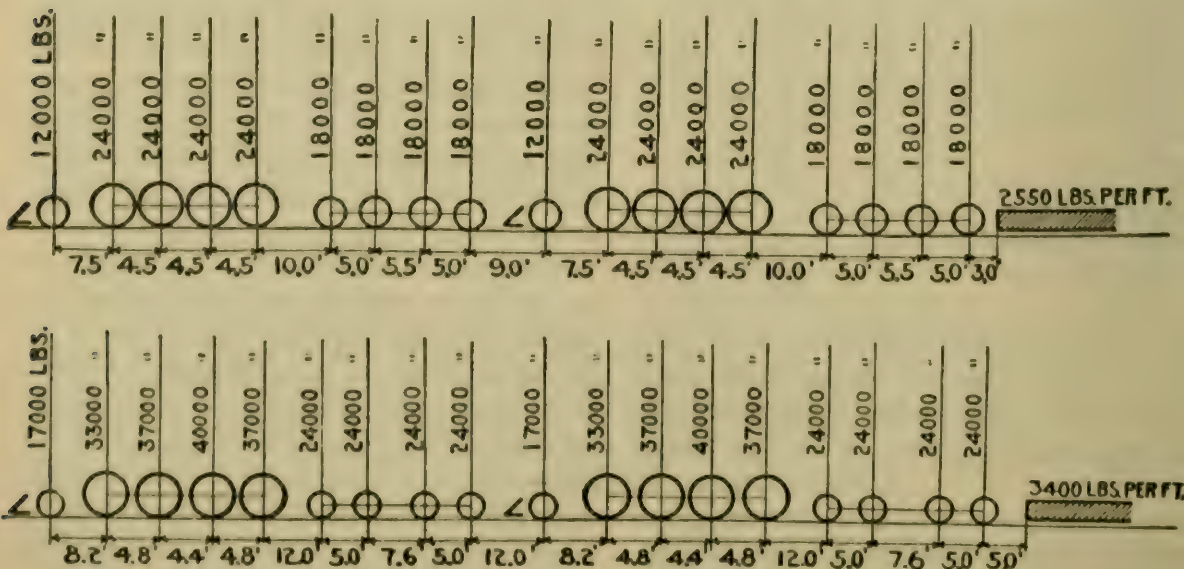
"The heavy loading shall be a uniform load of $\left\{\frac{160,000}{S}+3,400\right\}$ pounds per linear foot of track, in which S=the span length for girders and trusses; the panel length for stringers, end floor beams, and similar members; the sum of the lengths of adjacent panels or spans for intermediate floor beams, suspenders, subposts, cross-girders, and piers.

"The above heavy loading is the equivalent of two coupled engines and train, shown in the preceding diagram, with additions for impact varying from 50 per cent. at 15 ft. length of span to 10 per cent. at 100 ft.

"The light loading shall be a uniform load of $\left\{\frac{120,000}{S}+2,550\right\}$ pounds per linear foot of track.

"Note.—This is three-quarters of the heavy loading, and consequently the live load stresses in all parts of spans will be three-quarters as great, which consideration will facilitate the preparation of strain sheets where both loadings are used for spans of the same dimensions.

"The above light loading is the equivalent of two coupled engines and train, shown in the diagram, with additions for impact varying from 80 per cent. at 15 ft. length of span to 10 per cent. at 100 ft.



TRAIN BASIS FOR LIGHT AND HEAVY LOADING.

"Note.—The greater addition for impact in small spans for the light loading serves to cover stresses induced by the greater concentration of weight in tank and passenger engines.

"The centrifugal force on curves shall be assumed to act 5 ft. above base of rail, and shall be computed for a speed of (50–2*d*) miles per hour, in which *d* is the degree of curve.

"A wind force of 30 lbs. per sq. ft. shall be assumed to act upon the surface of the floor, double the surface of other parts, and a moving train surface 10 ft. high.

"Stresses from dead load and wind force shall be taken at unit stresses 50 per cent. greater than those hereinafter specified for live load and centrifugal force.

"The stress per sq. in. for live load and centrifugal force shall not exceed the following:

"*Tension.*—Rolled bars and flanges of girders, 10,000 lbs.; plates and shapes, 8,000 lbs.

"*Compression.*—All compression members, which must not be over 48 diameters long,

$$\frac{8,000}{1 + \frac{L^2}{18,000\,R^2}}$$

in which L=length between supports in inches. R=least radius of gyration in inches.

"Field rivets and adjustable members, to be taken at 20 per cent. less than the stated stresses.

"Stresses in steel shall be taken 15 per cent. greater than given above for wrought iron.

"Provision shall be made for expansion and displacement by an allowance for motion of 1 in. for each 70 ft.

"All spaces must be provided with drains or filled with improved waterproof-material to effectually prevent the lodgment of water.

"In steel and forged-iron members the section around pinholes in tension members shall not be less than two-thirds the section of such members.

"Bends in iron must be made hot. Bends in steel must be made cold, and the whole piece subsequently annealed.

"Steel must be made by the open-hearth process, and shall contain not more than .08 per cent. of phosphorus.

"Samples shall give the following minimum results when tested, *viz.*: ultimate strength, 62,000 lbs. per sq. in.; elastic limit, 34,000 lbs. per sq. in.; elongation in 8 in., 22 per cent.; reduction of area, 44 per cent.

"Full-size eyebars shall have a minimum ultimate strength of 60,000 lbs. per sq. in., and elongation of 15 per cent. in 15 ft."

Prevention of Fire.

As an excellent example of enterprising management, we here notice the circulars sent out free by the Boston Manufacturers' Mutual Fire Insurance Company, through Mr. Edward Atkinson, its president. It is certainly not a new idea that it is to the interest of insurers to prevent losses by fire, yet it is not common for insurance companies to go to the expense of making experiments to determine for their members the best methods and appliances to use in preventing fires. "Circular No. 63," as in the case of all others of the series, is issued for free distribution, and treats of "Fire Retardents on Wooden Surfaces." This is a subject of interest to property owners, but still more so to designers and builders of all forms of structure. The architect and civil engineer unite in producing structures as nearly fireproof as conditions will permit. Speaking of the experiments performed by his company, Mr. Atkinson says: "The object of these tests has been to determine the relative value of materials which can be put up without being subject to the objections applying to plastering." If the timber and plank are varnished, the danger of catching fire is increased, even though the wood itself is not highly combustible. "The first rule for avoiding the rapid spread of fire on wooden surfaces is therefore TO FORBID ABSOLUTELY THE SMEARING OVER OF THESE SURFACES WITH ANY OF THE ORDINARY TYPES OF COMBUSTIBLE VARNISH. The next remark may be that some of the fire-proof paints, so-called, will retard ignition from small cause nearly as well as a good coat of well-made whitewash; there are one or two which will retard a fire a little longer than whitewash, when applied to inside surfaces, but, as against high heat, neither paint of any kind nor whitewash will serve any considerable length of time. Our undertaking has, therefore, been to find materials of sufficient thickness and of sufficient non-heat-conducting properties to retard both the spread of fire from small cause and also to retard the combustion of the wooden surfaces as long as possible under high heat." All the specimens received from manufacturers were tested under similar conditions. "All were cut seven inches square, and each was applied to a piece of soft pine wood, seven inches square and one-half an inch thick. The wood was carefully inspected, and was free from knots, shakes, and splits. The specimens were tacked to the wood along the edges where the tacks were not exposed to the heat. The pieces of pine thus protected by the material to be tested were exposed to a blast of hot gases from a brick furnace. By the use of several Bunsen burners and wire nettings a column of gases six inches square and of nearly uniform temperature could be directed upon the under side of the specimen. The temperature was determined and kept constant by a Le Chatelier pyrometer. A series of tests was made, first, by exposing the specimens to the blast at a temperature of 1,600 F. for ten minutes. The efficiency is estimated from the depth of charring in the wooden backing. A second test was made by exposing each specimen to the blast at a temperature of 2,400 F., until the backing caught fire. The efficiency is rated on the time elapsing before ignition. The two ratings are identical, excepting in the case of the H. W. Johns Co.'s 'Superator.'"

The results of the individual tests are given in Table I., not produced here.

Table II. contains a list of the best materials in the order of their efficiency. Column 1 gives the name of the material; column 2, the grade or thickness; column 3, the depth of charring; and column 4, the time elapsing before ignition of the wooden backing.

TABLE II.

1	2	3	4
Material.	Grade.	Depth of charring.	Minutes before ignition.
Salamander...	No. 4.	0	14
Wall Board........	Cement finish.	0	8
" "	Plaster finish.	0	8
Fire Felt...	¼ inch.	0	7
Salamander........	No. 3.	$\frac{1}{16}$ in	5
Wall Board	Plain.	⅛ "	5
Air Cell...........	3 ply.	⅛ "	4½
Wall Board........	Fancy.	⅛ "	4
Fire Fel	⅛	¼ "	3½
" "	$\frac{3}{32}$	...	3

"We may add that the question whether or not a fire is to be destructive is usually determined in the first five minutes. Hence it follows that any material which can be put upon wooden surfaces at a reasonable cost, and which will hold a fire for five minutes or more, will probably serve its purpose by enabling an effective fire department to reach the place and to extinguish the fire."

The true method of protecting iron and steel from the destructive effect of heat either within the building or striking upon the building from without is yet but partially solved. An organization has lately been made for making the most complete and adequate tests.

Montreal, Ottawa, and Georgian Bay Canal.

WHILE the New York State ship canal is under discussion, our Canadian neighbors have again revived a similar scheme,—that of connecting Lake Huron with the lower St. Lawrence river. Mr. Macleod Stewart, in *The Canadian Engineer*, comments upon the scheme as "involving no unreasonable expenditures," and one "in the carrying on of which no unusual engineering difficulties are to be met with; and those difficulties which do exist are within certain defined limits, and already known with a fair degree of accuracy from surveys made at different times." Speaking of the various routes, he says: "The Ottawa river is supremely suited to become a great highway for traffic. Geologists say that formerly a large portion of the waters of the great lake region found their way eastward through the Ottawa, which probably constituted their main channel until an upheaval of the country about Lake Nipissing, and a gradual draining of the basin, led to their gradual division to the present course through the Niagara river." This region "would afford an open navigation often preferable to that of the great lakes themselves, because of the immunity from the effects of storm and head-winds enjoyed on these land-locked waters." . . . . Mr. Shanly made a survey (1858) estimating the complete cost at that time of 58 miles of canal construction at $18,500,000. Mr. Clarke (1860) estimated the cost as not more than $15,000,000, in which several other engineers concurred. The former plan provided for a canal 10 ft. deep, while the latter contemplated a depth of 12 ft. These, of course, were old-time estimates, which superior facilities to-day would reduce materially. This canal would make the route to Liverpool 885 miles shorter than the one by the way of New York.

Organization of a Fire Department.

IN connection with "circular No. 63," issued by the Boston Manufacturers' Mutual Fire Insurance Company, we here abstract from the next in order, as the subject is directly related, though not properly included under civil engineering. "Circular No. 63" treats of tests of fire-proofing material.

In "Circular No. 64" suggestions are given to mill-owners as to the organization of an individual fire department among their employees. Mr. Atkinson would officer the fire company as follows:

"Chief of department—agent, or general manager.

"First assistant — superintendent of mills.

"Second assistant chief of department—master mechanic.

"(The number of additional chiefs to depend upon the size of the works and the number of hose companies in the department.)

"Engineer—chief engineer of mills.

"Assistants — assistant engineers of mills."

The first assistant chief acts as a vice-chief. The second assistant has charge of the pipe and hydrant system, making at least two inspections a year. He also makes "weekly inspections of pumps, valves, and all fire apparatus, such as hose, hose-carriages, and all fire tools," making written reports to his chief on appropriate blanks. It is the duty of the engineer to inspect all pumps, and to see that the steam and rotary pumps are always ready for action; his assistants have personal charge of these pumps and operate them during fires. "The department shall be divided into two divisions:

"Division No. 1. Hose Companies.—The number of hose companies shall depend upon the number of hydrants about the works, and the number of men employed. Each company shall consist of a foreman, assistant foreman, hydrant men, and four hose men. The foreman shall have general charge of his company, and act under the direction of the chief and his assistants. The assistant foreman shall assist the foreman in the discharge of his duties, and act in his place in his absence. The hydrant men shall be two in number and it shall be their special duty to couple the hose at the hydrants, and to turn on and off the water. One of these men shall always remain at the hydrant; the other shall assist in handling the hose. Hose or pipe men shall be four in number,—that is, enough to handle two streams. These men should be heavy and strong and well-practised in the method of holding play pipes.

"Hook and Ladder Company.—Where works are large, it is well to have separate hook and ladder companies, composed of men three to six in number, who shall take charge of all ladders, erect the same, and act as assistants in handling the hose.

"Division No. 2.—This division shall consist of the overseers in the mills, their second hands and assistants, being composed wholly of inside men. They shall take charge of all the apparatus inside of the mill, acting under the direction of the overseer, and also shall act as a protective department. Each overseer shall see that all fire apparatus of every description in the rooms in his charge and in the towers adjoining the same is in good order ready for immediate use. In time of fire, it shall be the duty of the overseers and their assistants to remain in their rooms, to see that windows, fire doors, shutters, etc., are closed, and to do everything in their power to keep the fire from entering their departments, by the use of fire pails, small hose streams, etc. In the room where the fire occurs the hydrants and hose shall be under the charge of the overseer, until the arrival of the regular men of Division 1, who will then take charge of the same. It shall also be the duty of men belonging to Division 2 to do all that they can, under the direction of the overseer, to protect the stock and machinery from damage by water by covering the same with blankets or any other waterproof material which may be at hand. In the card room the laps themselves may be used to protect the card clothing.

"Selection of Men.—In the selection of men for Division No. 1, preference shall be given first to the skilled mechanics, second to the yard hands, third to men employed in the dyehouse, if there is one.

"Suggestions for Drilling the Men in the Use of the Apparatus.—Regular meetings of the department shall be held at least once in two weeks. It is suggested that they be held on Saturday. At these meetings the men shall be thoroughly drilled in the use of the apparatus in such a manner as will accustom them to quickly couple up the hose and bring the streams into operation. They should be accustomed to handling the hose on ladders and carrying the same up on to the buildings. By doing this the men soon come to have confidence in themselves, and, when a fire occurs, they will work more readily and without the excitement that they would be under if they did not have this drill. It is of the utmost importance that the watchmen, who during the night time constitute the whole force on the premises, should be especially drilled in the use of the apparatus and instructed what to do in case of fire. Whether or not any payment should be made to the members of the fire brigade is left to the decision of each manager. It has an excellent influence to make a small payment, and to make it in some senses a privilege to belong to the department by giving an annual outing and holiday to members."

Specifications for Brick Paving.

OWING to the growth of the paving-brick industry in the central States, and the large amount of money expended by municipal authorities, it has become necessary to closely define the conditions under which contracts are let in order to do justice to competing contractors. The town of Peoria, Illinois, according to *The Engineering News* (Nov. 21), has drawn up an unusually complete set of street-paving specifications for this year as follows:

"The foundation is to be 6 in. of concrete, composed of 1 part natural cement, 1½ parts sharp sand, and 4 parts broken stone concrete, covered with a 2½-in. cushion of sand. The size of the bricks is to be 2½×4×8 in., or 3×4×9 in., and they are required to withstand the following tests: (1) a transverse test flatwise, in which they shall show a modulus of rupture of 2,200 lbs. per sq. in.; (2) an absorption test, in which, after 48 hours' immersion, they shall show an absorption of not more than 2 per cent. of their own weight; (3) an abrasion test, in which 12 bricks are placed in a cylindrical rattler, 24 in. by 3 ft., with 300 lbs. of smoothly-worn scrap iron, in pieces varying from ¼ lb. to 5 lbs. in weight, and revolved one hour at 15 revolutions per minute, after which the loss by weight for the smaller brick is to be not more than 9 per cent. and of the larger brick not more than 7 per cent. The cement is to be tested for fineness, time of setting, soundness, and tensile strength. In the pavement the bricks are to be set on edge in rows running transversely across the street, except at street intersections, where the rows shall make an angle of 45 deg. with the curb lines. After laying, the bricks are to be settled by a roller weighing not less than 250 lbs. per lin. in., or by tamping by a 60-lb. rammer on a 2×12-in.×12-ft. plank. The joints are to be filled with sand."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Bridges.

†2517. The Best Substructure for Small Highway Steel Bridges. John H. Burnham (Advocating stone that will withstand frost, but as this is scarce in Illinois, steel I beam posts on mud sills with plank or iron backing are sometimes used but are not as good as stone for abutments, though cheaper). 10th An Rept of Ill Soc of Eng & Surv. 600 w.

2555.—$1.5c. What Is the Life of an Iron Railroad Bridge? J. E. Greiner (Read before the Am. Soc. of Civ. Eng. with discussion and correspondence. An interesting discussion on the factors necessary to consider in bridge design, and the effect of increased weight and speed of railroad equipment on bridges already up; a table of safe allowable unit stresses proposed for use in new designs. Considerable information is brought out in the discussion). Trans Am Soc Civ Eng–Oct. 20500 w.

2577. Steel Arch Highway Bridge, Lansing, Mich. Ill. (A bridge carrying Michigan Ave. over the Grand River, composed of two 110-ft. arched girder spans, supporting a roadway 115½-ft. in width over all. The ends of the 4 ft. girder arches are pin connected; the bridge is noteworthy by reason of its unusual width). Eng News–Nov. 14. 300 w.

2586. Union Pacific Railroad Bridge Specifications (These specifications for 1895 make the live load equal to a uniform load including the effects of impact, and include qualification of material and workmanship, construction and drawings. The article gives extracts from the more important provisions). Eng Rec–Nov. 16. 1500 w.

2591. Temporary Trestles over Washouts (Abstract from a committee report to the Assn. of Supts. of Bridges and Buildings, with details of methods considered best in opening the road to traffic). R R Gaz–Nov. 15. 1200 w.

2726. Phoenix Bridge Company Specifications (The extracts given indicate that the specifications are full and valuable as there is no point in common practice which is left in doubt in either railway or highway bridges). Eng Rec–Nov. 23. 1800 w.

2789. A Bridge Over the Danube at Cernavoda. Ill. (A five span bridge 2460 feet long, costing $1,567,456 for the main bridge). R R Gaz–Nov. 29. 1000 w.

2838 The Spring Avenue Bridge, Troy, N. Y. (Detailed illustrated description). Eng Rec–Nov. 30. 2000 w.

2970. The Minneapolis Arch Bridge (General elevation, and sections, details of viaduct, approach spans, arch trusses and tower). Eng Rec–Dec 7. 700 w.

Canals, Rivers and Harbors.

†2515. Location and Alignment of Drainage Districts. D. L. Braucher (Maintaining that easy curves and long tangents are of the greatest importance in locating a drainage channel). 10th An Rept of Ill Soc of Eng & Surv. 700 w.

*2524. The Nicaragua Canal. Archibald Colquhoun (An address at the London Chamber of Commerce stating that the cost of the canal will aggregate 20 million dollars with a probable annual return of 9 %. He discourses at length on the immense advantage it will be to the trade of Eastern United States and the leverage it will give them in competition with English trade in the East). Ind & Ir–Nov. 1. 700 w.

*2527. Navigation of the River Parrett—Proposed Ship Canal to Bridgwater. Ill. E. Duncan Stoney (A prize competition design fully illustrated by drawings of contours, sections and structural details, with itemized cost sheet. A well prepared article). Eng, Lond–Nov. 1. 2600 w.

*2571, Canal Boat Towing Test on the Erie Canal. Ill. (Report of the test at Tonawanda. By the side of the tow-path are two cables; the upper 1¼ in. cable is 16 ft. from the ground and supports the motor, the smaller ⅝ in. cable is wound around the hauling drum of the motor and carries the return current. Five loaded boats were towed at the rate of 4.7 miles per hour. It is estimated that this method will reduce the cost 82% over mules, and 55 % over steam. The test was under official supervision). St Ry Rev–Nov. 15. 1300 w.

*2573. Cawley System of Canal Haulage. Ill. (The boats are drawn by electric motors running on elevated tracks beside the canal. The motors run on two tracks, one above the other, so that there is no interference in passing each other. They are controlled from the boat). St Ry Rev–Nov. 15. 150 w.

2698. Transportation on the Pennsylvania Canal (Canal transportation of freight and passengers in the forties across the Allegheny mountains to Pittsburg, with illustrations of the boats used). Am Mfr & Ir Wld–Nov. 22. 500 w.

2806. The Report of the Nicaragua Canal Commission (An alleged abstract of the report as published by the *N. Y. Herald*. The commission report a necessary expenditure of double that estimated by the company, and bring other facts to light which discourage the scheme). Eng News–Nov. 28. 2000 w.

Hydraulics.

*2465. Location and Construction of Dams. Ill. J. B. Johnson (Showing the means of securing imperviousness and stability in dam-building). Eng Mag–Jan. 4500 w.

2758.—$1.50. The Discharge of the Mississippi River. Map. William Starling (A very exhaustive paper showing the great difficulty of obtaining uniform results. The work in its general principles, the use of formula, and system of observations is given in full; also the results of previous work). Trans Am Soc of Civ Eng–Nov. 50000 w.

2929. Water Power—Its Generation and Transmission. Samuel Webber (This paper, read before the Am. Soc. of Mech. Eng., contains facts regarding rainfall, drainage, efficiency of turbines, and cost of water power plants). Ir Age-Dec. 5. 700 w.

Irrigation.

*2466. The Law of Water and Modern Irrigation. Richard J. Hinton (Reviewing the United States Circuit Court decision that the California laws creating municipal irrigation districts are unconstitutional, and favoring State ownership of water). Eng Mag-Jan-3800 w.

2580. Artificial Stone and Concrete Work. Ill. (A drainage canal twelve miles long, with a section five feet wide at the bottom, 12 ft. at the top, and 5-ft. deep. The ditch is lined with cement which is said to have doubled the discharge. Three half tones illustrates the canal finished and under construction). Min & Sci Pr-Nov. 9. 200 w.

Miscellany.

*2478. The Blackwall Tunnel (An editorial account of a visit to the recently completed subaqueous portion of this important work. Remarks followed by a description of the construction). Builder-Nov. 2. 2500 w.

†2513. Photography for Engineers. John W. Alvord (Giving the experience, amusing and instructive, of an engineer with a camera, and how he uses it to illustrate his reports, etc). 10th An Rept of Ill Soc of Eng & Surv. 1800 w.

†2514. The Value of Marked Trees in Fixing of Survey, etc. I. H. Serviss (Showing that marked trees are the best witnesses as to the location, and how the date of survey may be determined by cutting out the mark and counting the rings of growth). 10th An Rept of Ill Soc of Eng & Surv. 400 w.

†2516. Easement Curves in the Race Track. D. L. Braucher (A plan for an oval race course with mathematical calculations and cut illustrating manner of laying out). 10th An Rept of Ill Soc of Eng & Surv. 1100 w.

2536. The Maintenance of Macadamized Roads. Thomas Aitken (A paper read before the Inst. of Civ. Eng's. on the use of machinery for repairing roads in the county of Fife, Scotland. Stone breaking, rolling, and cleaning the surface are fully described). Eng Rec-Nov. 9. 2500 w.

2547. Concrete Construction. Henry A. Gray (Giving the results of observations of English practice, with many figures relating to mixtures, etc., and methods of using). Can Eng-Nov. Serial. 1st part. 2200 w.

*2549. The Blackwall Tunnel (Account of the inauguration ceremony, and a description of a tunnel 27-ft. in external diameter, and 6200-ft. long, under the Thames, constructed under unusual difficulties and at a cost of over £1,000,000). Trans-Nov. 1. 2700 w.

*2550. Dock Gates and Pumping Machinery (An interview with a contractor as to the more recent appliances in use). Trans-Nov. 1. 2000 w.

2553.—$1.50. Topography on the Survey of the Mexico-United States Boundary. J. L. Van Ornum (Read at the Annual Convention of the American Soc. of Civ. Eng., with discussion and correspondence. A paper written to show the adaptability of known surveying methods, especially in stadia work, and giving a general review of the methods adopted in the Boundary survey). Trans Am Soc Civ Eng-Oct. 8500 w.

*2656. Crushing Tests of Building Stone (A table compiled from the most authoritative sources, giving the crushing weight in lbs. per sq. in. and tons per sq ft. of stones from various localities). Stone-Nov. 600 w.

2686. Protection of Piles Against the Teredo. Ill. (The piles of a railway trestle were encased in vitrified culvert pipe, the joints being made with a pitch and sand cement, and the space inside filled in with sand and gravel. The plan has been very successful). Ry Rev-Nov. 16. 800 w.

2695. The Subway in Boston (Extract from report of Howard A. Carson, under the caption "Studies for Cross Sections," also regarding the ventilation of the subway, from report of S. Homer Woodbridge). W Elec-Nov. 23. 2700 w.

*2743. The Institution of Civil Engineers (Editorial comment on an extremely interesting lecture by Sir Benjamin Baker on the occasion of his occupying the presidential chair of the Institute of Civil Engineers. He shows in what ways a scientific society can be a material factor in the progress of the engineering profession, and states the specific ways in which such results may be obtained). Engng-Nov. 15. 2800 w.

2753. The Illinois Central and the Lake Front. Ill. (The Chicago terminal improvements, which will give one of the finest terminal arrangements in the country when completed. The total cost to be about $1,000,000). Ry Rev-Nov. 23. 3000 w.

*2764. Presidential Address of Sir Benjamin Baker (Delivered before the Inst. of Civ. Engs. The ideas are interesting both historically and on account of their practical tendency. Editorial comment). Eng, Lond-Nov. 15. Serial. 1st part. 8600 w.

*2766. Presidential Address of Mr. Archibald Denny (Delivered before the Inst. of Junior Engs. upon the apprentice system, and the handling of young men in the drawing office, the work, and in business positions). Eng, Lond-Nov. 15. 5500 w.

2790. Some Results of an Engineering Education (Editorial. Defining the engineer as "the flower of the human race," and stating that there is no training which makes a man more useful or successful). R R Gaz-Nov. 29. 800 w.

*2845. Remarks on Subaqueous Tunnelling by Shield and Compressed Air. J. H. Greathead (A paper read before the Inst. of Civ. Engs. describing the tunnel under the Thames, 73 feet below high water, and 10 ft. 6 in. in diameter) Col Guard-Nov. 22. 1800 w.

DOMESTIC ENGINEERING

The Poisonous Qualities of Acetylene.

The extensive adoption of acetylene for illumination, should this come to pass, will involve some new dangers to life and property. Nature allows man to utilize no one of her hidden resources without the risk of penalties for inadvertence or lack of due caution. The danger of the formation of explosive compounds when the acetylene gas is brought into contact with copper or alloys of copper has been noted in this magazine (vol. 9, p. 378). The poisonous qualities of acetylene (also called ethine), which take effect when inhaled pure or mixed with atmospheric air, have now been tested by Dr. W. H. Birchmore, whose experiments (an account of which is communicated by him to *The Electric Engineer*, Nov. 13) render it certain that a small portion of it mingled with air will, when inhaled, produce injurious and even deadly effects upon the human organism. The danger of small leaks in a system of piping used to distribute the gas to burners, or in the burners themselves, is obvious.

The first fact claiming attention is that, in an aqueous solution of the gas containing equal volumes of gas and water, the volume of acetylene that will evaporate is notably greater than that of the water vapor simultaneously escaping. It is also proved that the gas will continuously diffuse and escape through the water-seal of an ordinary gas-holder. Dr. Birchmore says:

" Twice in the course of my studies the opportunity occurred to measure the amount that, diffused in the air of the room, would produce distinct headache in the course of a short time, and it was found to be rather unexpectedly large as compared with the product of the imperfect combustion of the ordinary illuminating gases. As stated, the air in the room wherein the experiments were conducted was known to be changed once in an hour. The cubic contents of the room was about five thousand feet, if a proper allowance is made for the space occupied by properties. The amount of gas diffused was two and one-half cubic feet, or one in ten thousand. Within twenty minutes a decided headache was noticed, with a sense of dizziness, that was a sufficient warning to get into fresh air. The second time, the experiment was made of remaining until the sight was slightly affected; this proved very foolish, for, in the course of an hour after leaving the room, respiratory difficulty appeared, and, in the course of a few hours, nausea, and a prostration and sense of the impossibility of exertion that forced me to remain in bed all the next day. The effects were not those of sleep, but the exact counterparts of the subjective effects of the ether narcosis,—hallucination and all. Three days afterwards the heart respiration ratio was so sensitive that an attempt to walk rapidly across the Brooklyn bridge produced such a feeling of exhaustion as to compel rest.

" The important fact in this connection is that a man well acquainted with the smell of acetylene was twice in the room in the course of this experiment, and, on question afterward, said that he did not notice anything peculiar about it, and certainly had not noticed the 'smell of the acetylene.' It is possible that the very familiarity with this smell may have blunted his perception, but at the same time it may be urged that he would have been doubly sensitive, knowing the danger involved in breathing it. It is, therefore, safe to say that as much as one part in ten thousand may be diffused in the air of a room without being detected by the sense of smell in some persons, and that this amount can produce dangerous effects.

" Can this dose of one in ten thousand be considered fatal, and, if so, how long a time is required to produce this effect?

" Up to date there is no record of any attempt at 'suicide with acetylene for the sake of science,' but an experiment on a guinea pig gave the following results:

"Alarmed at my own experience, it seemed a good thing to know if a reasonable limit could be set to this sort of a thing; so a large, healthy guinea pig was confined in a tight box, containing two hundred and sixteen cubic feet. Experiment showed that confinement in this box under ordinary conditions for a period of forty-eight hours had no effect on his health, appetite, or spirits, although the air must have been much deprived of its oxygen, by the measure it sank below the proper respiratory limit for human beings; therefore I judged that any error that might get in would be on the safe side. At ten o'clock in the forenoon I drew out thirty-four cubic inches of air, and substituted ethine; in about ten minutes my prisoner was evidently uneasy, and in half an hour was hid away under the straw,—the usual habit of guinea pigs when in distress. They do not run about, as do some animals, and, when, at four o'clock, I opened the box, my pig was dead, and his blood had lost the power of absorbing oxygen almost as if killed by cyanogen. As the guinea pig is a rather hardy little beast under this sort of treatment usually, it seems certain that a man would or could be fatally injured by breathing a mixture of one part of ethine in ten thousand of air for six hours."

It is evident from these experiments that acetylene operates as an active and insidious poison, when taken into the circulation through the lungs, and that, while intermingled with air to an extent imperceptible to the sense of smell, it may produce very injurious effects. These facts will have to be very carefully considered and dealt with before acetylene can take any important place among domestic illuminants.

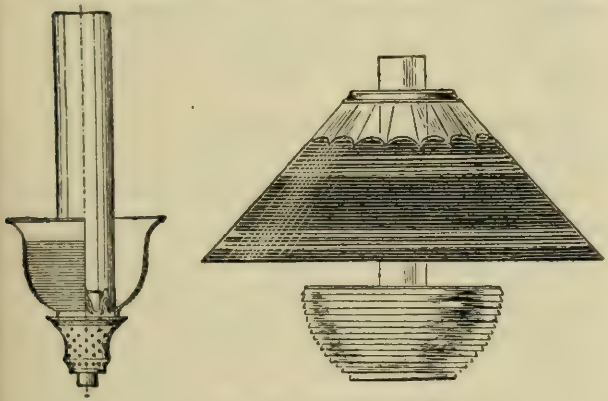
M. GREHAUT gives in *Comptes Rendus* an account of some experiments with acetylene which did not indicate so great toxicity as is attributed to it by Dr. Birchmore. M. Grehaut experimented with mixtures containing 20, 40, and 79 per cent. of acetylene (the mixtures in all cases having 20.8 per cent. of oxygen as atmospheric air); and he found that it is poisonous if inhaled in large quantities,—between 40 and 79 per cent. He asserts, however, that it is much less deleterious than coal gas. Mixed with oxygen, it is highly explosive. Referring to these experiments, M. Berthelot says the toxicity of acetylene would be much greater than it is, if it were mixed with carbonic oxid or hydrocyanic acid.

Doubtless others will be led to experiment upon the qualities of this gas, and there will not much longer be any uncertainty or difference of opinion as to their quantitative effect upon the human system. The question should be thoroughly settled in advance of the introduction of the gas for illuminating purposes, even at the expense of the lives of sundry rabbits and guinea pigs.

A New Lamp Globe.

A NEW French invention by Mr. M. Fredureau, which he calls a "*globe diffuseur*," has crossed the English channel, has been placed on sale in London, and is highly recommended by *The Gas World* (Nov. 16), the editor of which, having used one in connection with a Welsbach gas burner, asserts that the result is very pleasing and agreeable. The journal named describes the invention, which has been tested by Professor Sylvanus Thompson with the following results. Professor Thompson "found that, while a naked incandescent electric lamp gave only 8 c. p. in the downward direction, it gave 17.5 c. p. when fitted with a shade, and 34 c. p. when both a globe and a shade were used. As Professor Thompson's test indicates that the globe can double the efficiency, the shade can be dispensed with for most practical purposes."

The Gas World says the globes have a shape according with the laws of geometrical optics. "The inner surface of the globe is smooth, while the outer surface is provided with prismatic rings concentric with the center of the globe. If a section of these rings is examined, it is perceived that the upper rim of each ring is a segment of a paraboloid, and that the under rim is a plane. These different paraboloids have the same center as the globe, and that center for a focus. The result of this mode of construction is that the luminous rays coming from the focus are reflected and split on the upper surface of each ring, and return from the under surface parallel with the axis of the globe; the greater number of these rays illumine the region under the lamp, but a small quantity are reflected by the lower ring and are diffused, while a small portion is reflected into the interior of the globe. Those rays reflected into the interior of the globe are the most refrangible ones,—the ones most trying to the eyes. The globe can be used with either arc or incandescent electric lights, or incandescent or argand gas lights, or with circular oil flames; but the necessity of proper centering does not permit of its being applied with full effect to flat flames. Seen with the Welsbach light, the effect is decidedly striking; the mantle is apparently considerably lengthened, and the amount of light thrown downward is, as we have said, vastly increased, while the whole appearance is soft and pleasant to the eye. The principles that have been so successfully applied to the *globes diffuseurs* can be equally applied to projectors, which can be so placed as to project horizontally or vertically. The globes, which are but little heavier than plain glass globes, are made in a variety of sizes and shapes. The accompanying cuts will give a general idea of their appearance." Probably these globes will soon find their way into the American market.



GLOBE DIFFUSEUR

Professor Thompson says, further, that he has found the globes effective in concentrating the light in the desired direction, as indicated by photometric measurements. "In the case of arc lamps burning with continuous currents, it is well known that the usual mode in which they cast their light is an irregular distribution, having its maximum at about forty-five degrees, and having a deep shadow immediately beneath the lamp. When provided with a diffusing globe, the same arc lamp now gave its maximum illumination directly downwards, the light in the forty-five degrees direction being much reduced."

There is little doubt of the value of this invention for desk workers, draughtsmen, and those required to perform any kind of manual work by artificial light.

Air Gas and Incandescent Lighting.

THE following description of this innovation is an abstract of an article in *The Gas World*. .

The system has nothing to distinguish it from hundreds of systems that have lived, and died, before it, except this one feature, —that the carburation of the air is carried only to that point which gives a non-luminous flame. But it may well be that this difference, simple as it appears, may mean the difference between failure and success. Effort has been directed to combining the use of air gas with the employment of the incandescent burner. The system supplies to the air only sufficient liquid hydrocarbon to produce a non-luminous flame by means of a simple automatic arrangement which is thoroughly under control. One result of this small addition of hydrocarbon is that there is no condensation in the carburetter or in the connecting pipes; and another is that the Bunsen burner is not necessary for the proper combustion of the gas. The gas can be burned as well in a closed circular burner as in an ordinary batswing burner; for, as it contains within itself the oxygen necessary to combustion, no special effort is required to bring the oxygen to the point of ignition. The gas so made and so burned appears to work well with the incandescent mantle.

A burner is employed that combines the advantages of both incandescence and regeneration. This burner can be fitted into an ordinary regenerative lamp of the inverted type, or it may be placed in a pear-shaped globe, such as the electric light has made familiar. By the apparatus air can be carburetted equally well by coal gas,—that is to say, the gas and air can be mixed before reaching the burner, and not at the burner, as is the present practice, enabling a more regular and thorough mixture to be obtained.

More About Electric Heating.

In a paper read by Mr. J. Chester Wilson (April 30) before the Engineers' Club of Philadelphia, and reprinted in the *American Architect*, the author, after discussing the laws which govern the generation of heat in conductors, quotes the *Electrical Engineer* as asserting that the commercial efficiency of the coal cooking-range is as low as between 3 and 6 per cent. He also quotes a statement made before the London Society of Engineers, putting the average efficiency of a coal range—alleged to have been determined by actual experiment—as low as 4 per cent., and showing that only about 1 lb. of coal in 27 is actually utilized in kitchen ranges. He then states that in the electrical kitchen, in New York, on an 11 weeks' trial with electricity furnished at 5 cents per h. p., an average of ninety-seven persons were served at an average cost of 25 cts. each for the heat.

If these statements are absolutely correct, there seems to be some reason to hope that electric heating may be made available for domestic cooking. But, if the heat of ranges is estimated as wholly applied to cooking, the statement is not fair to the ranges. In cold weather a large part of the heat from a range, as ordinarily used, is utilized in house warming. In summer, the use of gas fuel for culinary purposes is largely increasing, and it will ultimately supplant coal for summer use in private establishments. So, to be fair in such a comparison, it should be made for coal ranges in winter, and for gas ranges in summer, and the heat value of the range for house warming in winter should be taken into account.

Fires from Steam Pipes.

In line with what was said in this department for December in relation to fires generated by heating pipes, *Machinery* (London) gives an explanation of the way in which such fires occur, and a reason why they are usually nocturnal. It says that " neither ordinary live steam nor superheated steam will heat a pipe thick and strong enough to convey it to a degree sufficient to produce a fire on wood, however dry. It will not even set charcoal aglow or in a blaze. But dry charcoal, when the heat is removed from it, being nearly pure carbon, will absorb oxygen from the air under favorable conditions so rapidly as to produce active combustion,—that is, a glow or a blaze. The process of the origin of a fire from a steam pipe will, in course of time, char, or, as the chemists say, carbonize, wood in contact or close to it. When this charring process extends to any depth in the wood, it presents a surface full of fissures and cracks, thus exposing a large section to the air. This process of charring drives the oxygen out of the charred portion, and keeps it out while the heat is kept up. When the heat is removed, the charcoal reabsorbs oxygen from the air, and, if the action is rapid enough, in a dry atmosphere combustion is the result. This explains why fires from steam pipes occur after the pipes have cooled.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Heating and Ventilation.

2537. Hot-Water Heating in a Country Residence. Ill. (The residence in which this plant is installed is that of Mr. John Jacob Astor, at Rhinecliff, N. Y. It is 84 × 88 ft. in plan and its situation is somewhat more than usually exposed). Eng Rec-Nov. 9. 1800 w.

*2552. The Heating of Buildings. George Hill (A general essay on the subject of warming buildings, covering the principal classes of buildings and their special requirements, and also the principal varieties of apparatus and appliances used for the purpose, with some practical suggestions relating to their successful installment and operation). Arch Rec–Oct.-Dec. 5000 w.

2636. Boiler Explosions. Ill. R. C. Carpenter (A general discussion of the subject with examples of explosions of steam, and hot-water boiler explosions in Canada and the United States, which, however, are stated to be very rare in proportion to the large number in use). Heat & Ven–Nov. 15. 1300 w.

2729. Hot-Water Heating of a Residence (Illustrated detailed description giving plans of floors, and particulars of a design in hot-water heating apparatus containing some unusual features). Eng Rec–Nov. 23. 450 w.

2730. Heating a Greenhouse (Illustrated detailed description of an unusual method of warming a greenhouse, now attached to a residence in West Superior, Wis., which was also one of the exhibits at the World's Fair, in Chicago). Eng Rec–Nov. 23. 200 w.

*2762. A Study of the Heating and Ventilating Plants in the Suffolk County Court House and the Massachusetts State House, Boston. Ill. Percy N. Kenway (A comparison of results in two buildings very nearly alike in size, exposure, and conditions of use, but supplied with radically different heating plants. A very interesting and instructive study in the art of heating and ventilation). Jour of Assn of Engng Soc–Oct. 5300.

2842. The Ventilation of Railway Coaches (Present and possible ventilation of railway coaches discussed from a mechanical standpoint). Eng Rec–Nov 30. 2500 w.

2968. A Complex Job of Steam Heating. Ill. (Reprinted from the *Plumbers' Trade Journal.* Describes a complicated job of steam fitting wherein a new set of appliances was joined to an old one, in a college building). San Plumb–Dec. 1. 500 w.

2971. The Heating and Ventilation of the German Theatre, Chicago (Illustrated detailed description with plans of basement and each story. A good study in heating). Eng Rec–Dec. 7. 2300 w.

Landscape Gardening.

2603. Save the Palisades. From the N. Y. Times (On the destruction caused by quarrymen and the necessity of speedy action if the beauty of the palisades is to be preserved). Forester–Nov. 1. 1300 w.

2645. Seasonable Work Among the Trees (Editorial remarks regarding the planting of trees and the cutting, trimming, &c). Gar & For–Nov. 20. 1200 w.

2781. Schools of Horticulture (Editorial comment favorable to these schools, with an account of the latest meeting at Jamestown, N. Y). Gar & For–Nov. 27. 1100 w.

Plumbing and Gas Fitting.

2474. Dry Insulator for the Detection of Leakages of Gas (Describes and illustrates a new apparatus for detection and location of leaks in gas-pipes). Sci Am Sup–Nov. 9. 600 w.

2589. Some Plumbing Details in the residence of John J. Astor. Ill. (An instructive description, especially to those who wish to familarize themselves with the best examples of high class sanitary plumbing). Eng Rec–Nov. 16. Serial. 1st part. 2000 w.

*2702. Fredureau's Light-Diffusing Globes (Illustrated description of these globes and explanation of their operation, their configuration being claimed to strictly accord with laws of geometrical optics). Gas Wld–Nov. 16. 700 w.

*2708. Possibility of Simple and Safe House Plumbing. Herbert J. Bowman (Paper read at the annual meeting of Medical Health Officers for Ontario. An examination of statutory plumbing regulations compiled in 1884, concluding that some changes and additions will be required when the statutes are revised). Can Arch–Nov. 2500 w.

2967. Plumbing Fixtures of the Past and Present (Proposes to describe, with illustrations, the principal plumbing fixtures and appliances of past and present time. The first part treats of water closet, bath and lavatory fixtures). San Plumb–Dec. 1. Serial. 1st part. 900 w.

*2972. Sanitary Appliances and the Principles of Ventilation. A. Wynter Blyth (The fourth of a series of lectures at Carpenters' Hall. Dealing chiefly with water closet construction and ventilation, with some remarks on dwelling ventilation). Arch, Lond–Nov. 29. 3000 w.

*2977. Interview with M. Bandsept (Reported for this publication. An exposition by the inventor of the advantages of the Bandsept burner now attracting considerable attention abroad). Gas Wld–Nov. 30. 1300 w.

Miscellany.

2539. Air Gas and Incandescent Lighting (This is a new system of lighting in which a non-luminous gas that will burn with sufficient heat is rendered luminous by bringing it into contact with a mantle that is rendered incandescent. Air gas, that is, air charged with hydrocarbon vapor only to a point that will cause it to burn without luminosity is used). Am Mfr & Ir Wld–Nov. 8. 1000 w.

2545. The Physiological Action of Acetylene. W. H. Birchmore (General conclusions deduced from experiments bearing upon the amount of the gas that can be diffused in the air of a room without perception by the senses; the amount required to produce headache; and the amount and time required to produce a fatal effect). Elec Eng–Nov. 13. 1200 w.

2688. Chimneys' Science (Relates some very instructive experience with chimneys and with stoves that would not work properly until they were properly connected with chimney flues). Met Work–Nov. 23. 2200 w.

*2770. On the Alleged Escape of Carbonic Oxide and Unconsumed Carbon from Coal-Gas Flames. Lewis T. Wright (A denial that danger or injury results in the ordinary use of coal gas either for lighting or heating as a result of unconsumed gases. Also contains some criticisims upon Mr. W. Thomson's experiments which appear to indicate that products of imperfect combustion may be present). Jour Gas Lgt–Nov. 19. 2500 w.

2972. The Requirement of a Bond from an Engineer (An able letter, written by Prof. S. Horner Woodbridge to the chairman of the committee of public property of Boston, declining to give a bond and stating reasons). Eng Rec–Dec. 7. 2000 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading and Domestic Engineering.

Storage Batteries Score Victories.

MANY able electricians, of whom the late Mr. Franklin Pope (at the time of his death editor of this department) was one, have regarded the storage battery as not possessing much value, except for a limited field of special applications. That it ever could compete successfully with the trolley system as a means of supplying electric motors for propulsion of tramcars was regarded by Mr. Pope as hardly within the limits of possibility, and entirely without the limits of probability. That the grounds for doubt appeared to such doubters sufficient to justify their expressed opinion is warrant in itself for the doubts of smaller men. But now and then some facts crop out which *prima facie* seem to indicate that, after all, they may have been mistaken. For example, Mr. Maurice Barnett in *Western Electrician* (Nov. 9) quotes an announcement from the *Kolnische Zeitung* to the effect that the trolley system in Hanover is to be discarded, and the twenty-eight cars hitherto propelled by that system are to be fitted and propelled by storage batteries.

He further states that, "since the announcement in the *Kolnische Zeitung*, news has been received that the Dresden Tramway Company and the Hague Tramway Maatschappy have likewise decided in favor of accumulator traction. Inasmuch as no less important a company than the Tudor Storage Battery company is making the installation, it is not at all too optimistic to believe in the ultimate success of the storage-battery cars about to be operated in the places named."

Upon these items of news, assumed to be reliable, Mr. Barnett significantly comments as follows:

" Up to the present time the engineers of the overhead system have had matters pretty much their own way. Occasionally a statement of results (coming in all probability from interested sources) bearing upon the success obtained with the open conduit has caused a commotion in the trolley ranks, but, save for that, the erection of poles has gone merrily on, and the manufacturers of trolley machinery have had no complaints to offer on the ground of lack of orders. The last two months, however, have seen the beginning of a mighty change. To-day the trolley is considered to have been merely coincident with the evolution of the modern passenger railway, and its usefulness in the future, at least in cities, is not likely to be greatly overestimated. E. H. Johnson, who, with Lieutenant F. J. Sprague, was the pioneer in working out the trolley method of electric transportation, writing in the *Electrical Engineer* under date of October 9, sounds the doom of the overhead line, at least in cities and towns. The reason for this belief is to be found in the objection to overhead construction, and, secondly, in the fact that greater economies are possible in the newly-projected closed-conduit system by reason of the fact that higher voltage may be maintained than is practicable in trolley systems. This criticism, emanating from one of the parents of the overhead wire system, may be considered to have some weight. Mr. Johnson also proceeds to pay his respects to the open conduit system, anent the great ado made by the Metropolitan Traction company of New York, 'over the practical success of their $150,000 per mile open-conduit system,' by saying: 'It was neither scientific nor business-like to place the electrical conductors in a sewer and then expend hundreds of thousands of dollars to secure drainage.' This represents the view that is at present held respecting the open-conduit electric system. Surely the friends of the electric accumulator can take hope in the discomfiture of their rivals."

Mr. Barnett further expresses the view

that the contest for supremacy in propulsion is now to be waged between the closed-conduit system and the storage-battery systems, and he predicts that within six months the critics who have been sneering incredulously at the storage-battery experiments now in progress on the Madison avenue line, in New York city, may be obliged to reverse their conclusions. Perhaps. Time is the arbiter of most disputes of this sort. We shall see. Meantime, there is something more to be said on the storage-battery side of the question, and Mr. Barnett says it. He points to the fact that in the power plant between Zurich and Hirslanden, Switzerland, where power is delivered from the dynamo under constant load, and accumulators are used to supplement power so delivered, a saving of $2500 per year on an investment of $7400 for the installment of the accumulators has been effected. This is an extremely satisfactory profit on the investment.

Again, it is asserted that in Germany and Austria eighty per cent. of all central stations are supplied with storage batteries of a single type, and that to this list may be added fifteen railway power plants and five thousand isolated lighting plants.

Other instances are cited both in this country and abroad, but these are passed by in this review, which we will close by quoting Mr. Barnett's list of the uses to which, in his opinion, the storage battery will be applied, with important results, in light, heat, and power stations.

"(1) As a 'reservoir' in which may be stored up the energy representing the difference between the average and the maximum demand on a generating plant; (2) as a regulator of pressure on circuits subject to fluctuating demands,—increasing the efficiency of the service and diminishing the wear and tear on apparatus; and, (3) as a transformer, to utilize high voltage charging current, and to discharge, when disconnected from generator, at any lower voltage desired.

"One fact that has been demonstrated, and which has the most important bearing on the construction of electric railway power plants, or, for that matter, of most electric light or power stations, is that, in any station which has to meet a fluctuating demand for power, a plant consisting of part steam power and part storage battery is cheaper in first cost than a total steam power plant would be for the same work."

Rating and Behavior of Fuse Wires.

THE fact that, notwithstanding all that has been said and written about it, the thermal cut-out is still alleged to be "one of the most unreliable of the many devices employed on electric circuits," as asserted in a paper having the above title in the *Transactions of the American Institute of Electrical Engineers* for October, amply justifies a return to it, and will continue to justify it as long as the unreliability continues. This paper, prepared conjointly by W. H. Stine, H. E. Gaytes, and C. E. Freeman, starts out with the assertion that, "beyond a few practical details of the device, it is little understood," and that, "as a source of vexation and uncertainty, the fuse is unrivaled."

The authors also assert that an "analysis of the literature of the subject shows that the theory of the thermal cut-out has been thoroughly investigated. The elements entering its action have been carefully studied and incorporated into fairly satisfactory equations. Yet all tests and treatments have shown the thermal cut-out to be subject to such variations that but little of practical value can be deduced from analytical investigations.

"These considerations led the writers to attempt further investigations. The fuse was dealt with as an auxiliary to electrical circuits, and its behavior under such conditions was carefully studied. The work in great part bears on points already treated of, but it was considered best to study the entire subject afresh, and endeavor to present a more or less complete discussion of the behavior of some of the ordinary alloys employed in practice. Naturally the data obtained are voluminous,—in all, some thirteen hundred determinations;" but the authors claim that "great care has been taken to thoroughly check all results."

A description, illustrated by a diagrammatic representation, of the arrangement of the apparatus is comprised in the paper, and this seems to accord with conditions in actual practice. "In all cases the fuse wire was carefully inserted, so as to obtain a uniform pressure of the wire under the screw head without unduly crushing it. The same block was used repeatedly, and little care to keep the terminals clean. This was done to more nearly imitate practical conditions. In only two or three cases out of hundreds of fuses blown did the rupture occur at the contact. Two classes of porcelain cut-outs were employed; one was the open porcelain base 'main line' style, the other the closed porcelain 'K. W.' variety. In the latter, the ten-ampere size has a space of only half an inch between its terminals, though the fuse is suspended out of contact with the porcelain base. This style of block has recently been condemned by the underwriters, and very properly. With the terminals so close together, a fuse blowing at twenty amperes invariably establishes a viscous arc, and the terminals melt with such explosive violence as to frequently shatter the block. Though the open type of block has an added fire risk, the terminals are, as a rule, further apart. A pronounced fault in their construction is that the terminals are let in flush with the surface of the porcelain. Nearly all types of porcelain fuse blocks merit severe criticism on several points. The terminals are too close together in small sizes, the fuse often resting on the top or base; and their mechanical construction is very poor. Too little attention seems to be given to the proper function of a fuse-block in its design." The timing was done by a stop-watch for periods exceeding one second, and by a chronograph for shorter periods.

Two series of tests were performed, the second series being with the open eight-inch block, and the results were tabulated for each series.

"The testing current passed through the fuse was measured accurately by first passing it through a Weston ammeter. It was thought best to take the resistance of the fuse into account, and adjust the resistance of the ammeter circuit to exactly equal that of the fuse circuit. To accomplish this, a current smaller than the known fusing current was sent through the fuse, and the fall of potential noted on a Weston milli-voltmeter. The current was next switched on the ammeter circuit, and the fall over this was made exactly that over the fuse circuit, by adjusting the compensating carbon rheostat. The fusing current, being accurately measured, was switched over on the fuse. The fusing time was thus accurately ascertained. A non-inductive resistance being employed, the time interval for the current to rise to its full value on the fuse was considered negligible for all but the very shortest periods." Numerous diagrams are also presented in the paper, which by curves illustrate the relative sensitiveness of large and small fuse wires, and show the curves of fusing points and curves of fatigue.

The first series of tests shows the unreliability of porcelain fuse blocks. The commercial rating of the fuse wire is also shown to be imperfect. One conclusion from all the tests is that "the blowing of the fuse is not immediately an electrical act. The current fuses the metal; the cross-section is reduced at some point due to gravity, unequal expansion, or 'sweating'; the heat is, in consequence, intensified at this point, and a globule falls, breaking the circuit and establishing an arc, which soon burns out a length of the fuse. This accounts for the sluggish action of such thermal cut-outs. An ideal fuse would be one that would act at approximately a constant time interval for all currents in excess of its normal. . . . In practice the curves of all thermal cut-outs must be more or less modified hyperbolas. The ideal curve could only be attained, were it possible to eliminate conduction and radiation losses. This is evidently the line to follow in designing a sensitive fuse block." Other practical conclusions are as follows: (1) covered fuses are more sensitive than open ones; (2) fuse wire should be rated for its carrying capacity for the ordinary lengths employed; (3) when fusing a circuit, the distance between the terminals should be considered; (4) on important circuits fuses should be frequently renewed; (5) the inertia of a fuse for high currents must be considered when protecting special devices; (6) fuses should be operated under normal conditions, to insure certainty of results; (7) fuses up to five amperes should be at least one and one-half inches long, half an inch to be added for each increment of five amperes' capacity; (8) round fuse wire should not be employed in excess of thirty amperes' capacity, and for higher currents flat ribbons exceeding four inches in length should be employed. These conclusions did not all pass without challenge. Mr. A. E. Kenelly disputed the alleged fact that covered fuses are more sensitive than open ones. If "sensitiveness" applies to the time in which the fuse wire will melt, he maintained, with good reason, that enveloping the wire by a mass of solid material would be simply reinforcing the fuse with additional material to be heated before the fusion could take place. The authors not being present, it was explained by the chairman that the term "covered fuses," as used by them, did not necessarily imply a closely-enveloped wire, but one surrounded by an inclosure of material having an air-space between it and the wire. Mr. Kenelly then admitted that, if that was the meaning of the authors, the conclusion criticised was valid.

Canadian Telegraph Lines.

THE beginning and subsequent progress of telegraphy in Canada, as set forth by Mr. Charles P. Dwight in a paper before the Canadian Electrical Association at the recent Ottawa convention (*The Canadian Engineer*, Oct.), is of sufficient interest to justify an abstract of it in this department.

The first commercial telegraph line in Canada was erected in 1847, between Toronto, Hamilton, St. Catherine's, and Niagara Falls, connecting with a line through to Buffalo, owned by one David Kissick. "The Toronto, Hamilton, Niagara Falls, and St. Catherine's Electro-Magnetic Telegraph Company" was the ponderous title of the organization which constructed the line. The title, however, expressed well the nature and scope of the company's business.

In the same year the Montreal Telegraph Company was organized, with a capital of $60,000, and by the end of the year was operating with 540 miles of wire, 9 offices, and 35 employees, and had transmitted 33,000 messages. In 1847, also, the British North American Electrical Association was formed to connect Quebec with the lower provinces, and ultimately with the Atlantic coast. This line was finally extended to Woodstock, N. B., where a connection was formed with the American Telegraph Company, afterwards absorbed by the Eastern Company. Each of these lines failed financially, and all, together with the line between Quebec and Montreal, were turned over, without charge, to the Montreal Company. In 1848 a line was built from Calais, Me., to St. John, N. B., and this line has now been incorporated into the New Brunswick Electric Telegraph Company, with a capital of $40,000. In 1849 a line was completed between St. George and St. Andrews, and in the following summer a line was constructed connecting St. John with Hampton, Sussex, Salisbury, Dorchester, Sackville, and Amherst, there connecting with the government line in Nova Scotia, built in 1849, thus first telegraphically connecting Halifax with New York.

In 1856 the lines of the New Brunswick Telegraph Company were leased to the American Union Telegraph Company, and some 10 to 12 years later came under the direction of the Western Union Telegraph Company.

The government line between Halifax and Amherst was sold in 1851 to the Nova Scotia Electric Telegraph Company, an organization chartered in March of that year, and which afterwards extended the line from Pictou to Sydney, C. B., and from Halifax to Yarmouth. Upon completion of arrangements for the landing of Atlantic cables in Newfoundland, the lines of the Nova Scotia Company were leased to the American Union Telegraph Company, which purchased the lines outright in 1872. In 1849 was organized the Montreal and Troy Company, which built a ine the same year from Montreal to the frontier, and thence, *via* Whitehall, to Troy. This company was organized by Ezra and Alonzo Cornell, who also constructed the line, and worked for several years afterwards in connection with the Montreal Company. A. B. Cornell, who, it will be remembered, was afterwards governor of New York State, acted as manager of the company at Montreal for 2 years after the construction of the line. Some years afterwards the section of the line from Whitehall north became the property of the Montreal Telegraph Company, under a compact with the American lines, known as the Six Party Contract, whereby certain divisions of territory were made and allotted to each company.

In 1850 was built a line between Montreal and Bytown. It was afterwards purchased by the Montreal Telegraph Company.

In the year 1852 the Grand Trunk Telegraph Company was organized. After a few years, it was purchased by the Montreal Company for the sum of $11,000. Then sprang up another organization, known as the Provincial Telegraph Company, which built a line over the same route, but it too was soon absorbed by the Montreal Company.

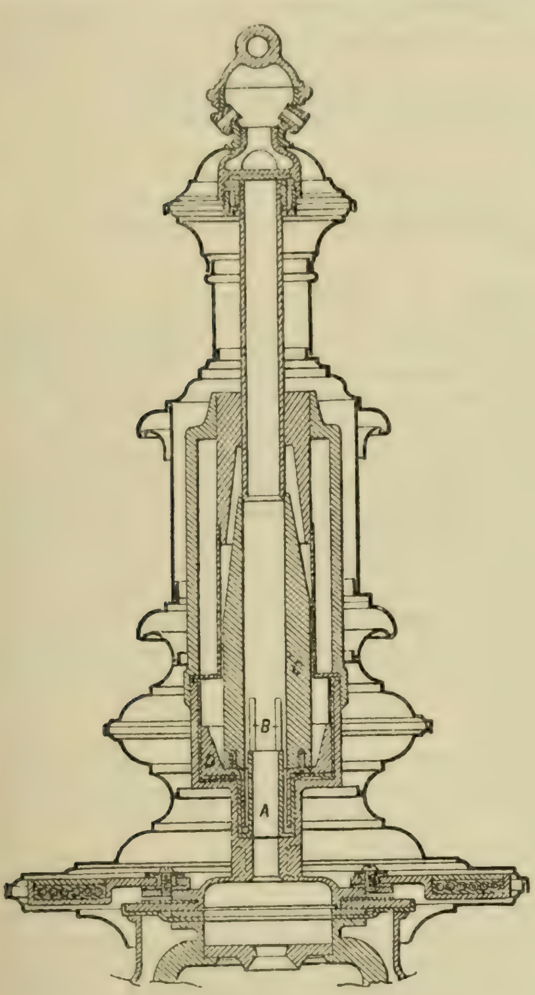
In 1868 was organized the Dominion Telegraph Company, which soon built lines embracing all the important points between Buffalo, Detroit, and Quebec, and whose opposition became more lively as time went on. Rates were reduced, and the outcome promised disaster for all concerned. Therefore, when a proposition was made in 1881 for the consolidation of these conflicting interests, under lease, by the Great North-Western Telegraph Company, considerable satisfaction at the prospect was expressed by all concerned, and a deal on these lines was accordingly put through, and is in effect to-day. The combined mileage of the two companies at the present time, as operated by the Great North-Western Telegraph Company, is 18,000 miles of poles, and 40,000 miles of wire, with about 1800 offices throughout Ontario, Quebec, New Brunswick, Manitoba, and New York State.

The total amount of capital invested in Canadian telegraphs may be roughly estimated at between $6,000,000 and $7,000,000, and the total wire mileage at about 75,000.

The Jandus Arc Lamp.

THIS is a new form of arc lamp, which, it is claimed, very materially increases the life of the carbons, and which is described in *Engineering* (Nov. 1). The celebrated electrician, Mr. Preece, has estimated the cost of carbons to be one-half the total cost of electric lighting in streets. A reduction of this consumption to any material extent will, therefore, result in a notable economy. The following is an abstract of the article referred to.

By completely inclosing his carbons in an air-tight globe, Mr. Jandus has increased the life of his positive carbon to such an extent that but ten inches or so of a half-inch carbon are burned in the course of two hundred hours, while at the same time the negative carbon wastes only about one inch. This slow consumption has other advantages, since it has allowed the mechanism of the lamp to be much simplified. No feed at all is given to the negative carbon, which is held in a fixed support. The device for feeding the positive carbon is shown in the engraving. The rod passes up the central tube, *A*, and is gripped by four gripping rings which pass through slots in the armature, *C*, two of which are shown at *B B*. The inner edges of these rings press against the carbon, while their outer edges rest on a conical headpiece, *D*, bolted to the armature, as shown. As long as the armature is held up by the attraction of the magnetizing coil, which is not shown in the engraving, the carbon is gripped with absolute firmness; but, if the armature falls, the rings come into contact with the upper edge of the tube A, and are raised so as to release the carbon, which then falls and reëstablishes the normal arc. The magnetizing coil is inclosed in a cast-iron case, and is provided with a conical pole-piece, and the top of the armature is also conical. In this way a very even pull is maintained through a wide range. About a pound and a half of wire are used in the magnetizing coil, the pull being seventy-three ounces. The contact for the upper carbon is obtained partly through the gripping rings already described, but mainly through a special contact-maker placed in the recess. This contact-maker consists of a large number of brass rings placed vertically around the carbon, and resting against it with their inner edges, the arrangement being to some extent similar to the gripping rings already described. The contact is, however, very light, but, as a large number of these rings are used, there is no trouble from sparking, even in the case of heavy currents. The arc is formed, in the first place, inside a small glass globe, which is not air-tight; but this globe is enclosed in a second larger globe, which is fitted with a valve opening outwards only. When the arc is struck, all oxygen inside the globe is rapidly burned up, and, as the gases inside expand from heat, most of them are expelled into the outer air through the valve already mentioned, leaving the arc to burn in an inert atmosphere. A long arc is used, the electromotive force being 75 volts, and the current from 3½ to 6 amperes. The all-round light is stated to be the same as in an ordinary type lamp taking the same energy.



JANDUS ARC LAMP.

The first cost of the lamp is not named, but, if, without sacrifice of illuminating power, the durability of the carbons can be increased as much as is stated, then, though this cost might exceed several times that of the ordinary arc lamp, the invention would be a great advance in the art.

Commenting upon the claims made for this lamp, *The Electrician* (Nov. 1) regards its efficiency as probably low, but thinks that the reduction of cost of carbons, "the possibility of using a low current, and the convenience of being able to connect lamps singly across circuits of one hundred volts," will render its success probable. It says that, "for lamps burning ten hours per night for a year, the length of carbon used in the old form to that in the 'Jandus' lamp is something like as five hundred and sixty feet is to thirty-five feet. The carbons burns fairly flat, instead of pointing and cratering on the negative and positive poles respectively. This result was to be expected when we take into account the long arc, the low value of the current, and the absence of an atmosphere surrounding the arc conducive to combustion. Prof. Silvanus Thompson has shown that the result of surrounding the arc with chlorine or carbonic oxid is that the carbons burn flatter. with a less perfectly developed point and crater. These results, together with state of the carbons in the 'Jandus' lamp, seem to prove the truth of the suggestion, which was made some time ago, that the cause of the peak on the negative carbon is the absence of an oxidizing agent in that region. Mrs. Ayrton has lately shown that the negative is less pointed, the smaller the current and the longer the arc. These three reasons for the flat burning of the carbons are all concurrently present in the 'Jandus' lamp in a high degree, compared with the usual arc lamp."

National Board of Fire Underwriters.

A RESOLUTION passed at a meeting of this board held Dec. 10, to revise rules for installing electric wires, has met with severe criticism. It is as follows:

"*Resolved*, That the superintendent be authorized, until further notice, to approve the use of the Attix tube and wire, when equal in quality and insulation to the samples submitted to this Board and tested, under the same conditions where tubing would be permitted; provided that there is no splicing or tapping of the wire, but that its introduction shall be in all cases by the loop system; that in new buildings when necessary to carry it between floors and plastering it shall be through holes bored in the beams, not less than two inches apart, a single conductor in each hole, out of the reach of nails; and in old buildings where necessary to carry it within the reach of nails it shall be protected by some device from perforation; and provided further that the wire and tube be carried intact into the cut-out boxes, and that in no case shall the outer covering be removed before introducing the core wire into the cut-out box."

Electrical Review, (Dec. 18) says the use of American Circular Loom Conduit, as such was also severely criticized. The resolution may be reconsidered.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Electricity in the American, English and British Colonial Technical Journals—See Introductory.

Lighting.

*2477. The Jandus Arc Lamp. Ill. (An account of a visit to the works of Messrs. Drake and Gorham, with the object of inspecting the working of the above named lamp, the principle of its action, and the facilities for its manufacture. It is claimed that this lamp, with a single pair of carbons will run without retrimming for 200 hours). Elect'n–Nov. 1. 1800 w.

2483. The New Electric Lighting Plant of the City of Chicago. Ill. (A description of the recently erected arc lighting plant at Halsted St. and Blue Island Ave). Elec Ind–Nov. 1600 w.

2544. The Reactance System of Arc Lighting. Ill. William Smith Horry (A description of a method of working arc lamps in series from the primary circuit of alternators without using a transformer, resistances, fuses, etc, to each lamp, and which is quite comprehensive enough for modern times, since a whole city can by this method be lighted from one machine). Elec Eng-Nov. 13. 1800 w.

2584. Pollak's Gleichrichter. F. H. Mason (Abstract from report of U S. consul-general at Frankfort, Germany. A device invented by a Frankfort engineer, which solves the difficulty of converting an alternating into a direct electrical current with the loss of but a trifling percentage of its energy). W Elec–Nov. 16. 800 w.

2694. West Side Park Lighting System. Ill (One of the largest arc lighting plants in Chicago, which will illuminate Humboldt, Garfield and Douglas parks and the connecting boulevards. Description, slightly abridged, from report of Mr. Forrée Bain, who planned the system). W Elec–Nov. 23 4800 w.

2750. The Use of Storage Batteries in Electric Lighting. Francis B. Crocker. (A communication read before the Amer. Inst. of Elec. Engrs. Considers separately eight principal uses. 1. To supply portable electric lamps. 2. To take up fluctuations and thus steady the voltage or current. 3. To furnish energy during certain hours of the day or night and enable the machinery to be stopped. 4. To aid the generating plant in carrying the heavier load which usually exists for only an hour or two. 5. To make the load on the engines more uniform by charging the battery when the load is light. 6. To transform from a higher to a lower potential by charging the battery in series and discharging it in parallel, or *vice versa*. 7. To subdivide the voltage and enable a three or a five wire system to be operated with a single dynamo. 8. To supply a current from local centres or sub-stations). Elec Eng–Nov. 27. 3000 w.

*2820. Tests of Incandescent Lamps (Gives a method whereby it is claimed the value of lamps to consumers may be obtained). Ind & Ir–Nov. 22. 1000 w.

†2878. Some Formula for the Calculation of Wires. Edward R Keller (Return Loop System. The object of the paper is to determine which of the methods ordinarily employed will give the most satisfactory results, and to present formulæ by which the wiring in such cases may readily be calculated). Jour Fr Ins–Dec. 900 w.

2942. A Model Electric Lighting Franchise for Montclair, N. J. (A copy of the ordinance granting the franchise, with remarks). Eng News–Dec. 5. 2500 w.

*2969. The Electric Wiring Question. Fred Bathurst (A paper read before the Inst. of Elec. Eng., England. Treats of the development and growth of wiring, technical requirements, present method, the advantage of tube or conduit methods, the superiority of an insulating tube, etc.) Elec Eng, Lond–Nov. 29. Serial. 1st part. 3500 w.

*2975. Concentric Wiring. Sam Mavor (Paper read before the Inst. of Elec. Engs., England. General remarks on various systems of wiring, specially presenting the advantages of concentric wiring). Elect'n–Nov. 29. 9000 w.

Power.

*2481. An Electro-Magnetic Railway System. Ill. (A description of the system introduced into England by the Westinghouse Company, with reference to the Lineff system). Elec Rev, Lond–Nov. 1. 1400 w.

*2482. The Diatto Underground Conduit System. Ill. (Abstract from the *Elektrotechnische Zeitschrift.* Seems to be a combination of the Lineff and the Westinghouse systems. It is similar to the Lineff in that it carries the electro magnet on the car, but it approximates to the Westinghouse in carrying a collecting bar, which collects current from metal studs). Elec Rev, Lond–Nov. 1. 600 w.

2484. The Electrical Development of the Falls of the Willamette. Ill. (Description of a long distance transmission plant at Oregon City, for supplying Portland and suburbs, twelve miles away. The total power of the fall is estimated at 50,000 horse-power. The completed plant will develop 12,500 horse-power). Elec Ind–Nov. 1400 w.

2487. The Electrical Plant of the Waterloo and City Railway. Ill. R. W. Weeks (A brief account of the general arrangement of the works). Elec Eng, Lond–Nov. 1. 2200 w.

*2492. On Hydro Electric Installations. C. S. Du Riche Preller (The first part contains an introduction which makes a classification of the applications of single phase, two phase and three phase alternate current. This is followed by an illustrated description of the two phase installation at Baden,—the first of a series of descriptions of a number of notable installations carried out by Messrs. Brown, Boveri & Co. of Baden, in various parts of Europe which are to be presented). Engng–Nov. 1. Serial. 1st part. 1700 w.

2588. The Power Plant of the Philadelphia and Reading Terminal Station. Joseph M. Wilson (Extract from a paper presented to the Am. Soc. of Civ. Eng. Description with drawings). Eng Rec–Nov. 16. 4500 w.

2596. Central Station Economics. Arthur V. Abbott and Franz J. Dommerque (Part I is a prefatory introduction consisting of a general statement of the conditions affecting the cost of producing power, with a scheme of the manner the subject is to be treated. Part II. will be an analysis of the elements involved in power production and delivery. Part III. Conclusion. Part IV. Relation of load line to design of plant). Elec Engng–Nov. Serial. 1st part. 3000 w.

2638. Effect of the Three-Phase System on Electric Power Transmission. Irving Hale (The enormous extension of the field of electric transmission by the introduction of the multiphase alternating system is shown, and its practical success demonstrated). Min Ind & Rev–Nov. 14. 1200 w.

2683. Storage Batteries for Railways. Maurice Barnett (A paper emphasizing the great value possessed by storage batteries, not in furnishing direct motive power, but when used in connection with railway power plants). Tradesman–Nov. 15. 2000 w.

*2736. The Electric Equipment of Messrs. Siemens' Works. Albion T. Snell (From a forthcoming work entitled "Electric Motive Power in Practice." An illustrated description of these works, with tests which seem to prove that power distributed from an electric central power station costs less than when derived from independent steam engines). Elect'n–Nov. 15. 3600 w.

2748. A Chimney Two Hundred and Thirty Feet High. Ill. (Interesting engineering feat in which an electric hoist rendered valuable aid). Elec Rev–Nov. 27. 700 w.

2749. The New Storage Battery Cars on the Madison Avenue Line, New York. Ill. (Description of the batteries, their location, and handling, shifting devices, etc. Also brief descriptions of the car bodies, truck and controller and the generating plant). Elec Eng–Nov. 27. 2200 w.

2751. The Storage Battery for Central Stations. Arthur E. Childs (Abstract of a paper presented at the meeting of the Amer. Inst. of Elec Engrs. Considering, in a general way, the application of storage batteries to the wiping out of the fluctuations and variations as they come upon the dynamos and engines). Elec Eng–Nov. 27. 3000 w.

2782. Electric Transportation of Express and Mail Matter (Illustrations of the proposed plan of construction, with explanation of system). Elec Age–Nov. 30. 1400 w.

2783. The Storage Battery or the Gas-Engine as an Auxiliary. Nelson W. Perry (Topical communication presented to the meeting of the Am. Inst. of Elec. Engrs. The author's opinion regarding the use of storage batteries for the purpose of relieving electrical systems of the strain due to sudden fluctuations of load. He considers the gas-engine preferable if economy is important). Elec Age–Nov. 30. 2200 w.

*2796. Sayers' Electric Motor and Generator. (An illustrated description of a new inclosed motor). Engng–Nov. 22. 500 w.

*2884. The Shunt Dynamo. Max Osterberg (Lecture delivered before the Henry Electric Club. Explanation of the principle and action). Elec Pow–Dec. 2100 w.

*2885. The Series Dynamo. Ill. Joseph T. Monell (Lecture delivered before the Henry Electric Club. Descriptive of different types). Elec Pow–Dec. 2500 w.

2901. Automatic Shoe Blacking Machine. Ill. (Descriptive of an electrical machine for named use). W Elec–Nov. 30. 600 w.

2902. Automatic Time Cut-out. Ill. (A device designed by F. B. Badt of Chicago, which the inventor claims will entirely obviate the short-circuiting of batteries). W Elec–Nov. 30. 1300 w.

2909. The Niagara Falls Hydraulic Power and Manufacturing Co.'s New Work. Ill. Orrin E. Dunlap (Descriptive). Elec Eng–Dec. 4. 1600 w.

2910. Direct vs. Alternating Currents for Long Distance Transmission. William Baxter, Jr. (The purpose of the article is to show that the direct current is more desirable than the alternating for the transmission of energy over long distances). Elec Eng–Dec. 4. Serial. 1st part. 2500 w.

2911. An Amalgamator Operated by Electric Motors. Ill. (An application of electricity of interest to the mining industry). Elec Rev–Dec. 4. 450 w.

2933. Electricity in Stone Quarries. Ill. (Consideration of the advantages, with an account of the electrical installation at the Hainaut Quarries, Soignies, Belgium). W Elec–Dec. 7. 1500 w.

2998. The Nevada County Power Transmission. Ill. (Description of an installation under many difficulties). Jour of Elec–Nov. 1600 w.

Telephony and Telegraphy.

2585. The Ten-word Telegram (Treating of changes in prices of messages in more recent years, comparing with previous prices, and the strong tendency to keep within the ten word limit). W Elec–Nov. 16. 1500 w.

2604. The Boughton Telephotos for Long Distance Visual Signalling. Ill. (Apparatus devised by C. V. Boughton. Description. Within the limits of vision it is asserted to allow of more rapid and certain communication than any other visual signalling system). Elec Eng–Nov. 20. 600 w.

*2711. Municipal Telephony. A. B. Bennett (A summary of the present position of telephones in the United Kingdom, and an account of what has been done in Norway are given in the present number). Elec Rev–Nov. 15. Serial. 1st part. 2800 w.

2769. How the Telephone Was Invented.—A Chat with Inventor Bell. Frank G. Carpenter, in *Washington Star* (An interesting talk on the telephone, Volta Bureau, and Mr. Bell's work in general). Inv Age–Nov. 4000 w.

Miscellany.

*2471. Are We Educating Too Many to be Electricians? Henry Floy (Showing, by specially-gathered tabulated statistics, that graduates in electrical-engineering are less suceessful than other technical specialists in obtaining remunerative employment). Eng Mag–Jan. 2700 w.

*2476. Energy Loss in Dielectrics. P. Gasnier (A review of what has already been done toward elucidating this question, and what are the conclusions which different experimenters have drawn from their work). Elect'n–Nov. 1. 2200 w.

2485. Practical Electrical Testing. Ill. C. C. Haskins (Brief descriptions of three methods for making a test or measurement of capacity, insulation, resistance and conductivity). Elec Ind–Nov. 800 w.

2486. The Design and Construction of a Motor Starting Box. Ill. E. D. (A consideration of the main points of a starting rheostat for a motor of five horse-power capacity, built for 230 volt circuits). Elec Ind–Nov. 1100 w.

2489. The Gravity Alarm Battery. William Brophy (Extract from address before the Massachusetts State Firemen's Asso. "What substitute (if any) is there for the gravity battery for fire alarm purposes that would be equally reliable and less expensive to maintain?"). Fire & Water–Nov. 9. Serial. 1st part. 2000 w.

2568. A Suggestion for a Dynamometer. Ill. George T. Hanchett (A description of one that is cheap and claimed to be as accurate as any of its class). Elec Wld–Nov. 16. 300 w.

2569. On an Approximate Linear Relation between Coercive Force and Maximum Cyclic Intensity in Iron and Steel. Edwin J. Houston and A. E. Kennelly (Results pointing to the existence of such relation). Elec Wld–Nov. 16. 900 w.

2581. Chase Electric Cyclorama. Ill. (An apparatus devised by Charles A. Chase consisting of "an ingenious combination of arc lamps, fed from rubbing contacts on a circular track suspended from the ceiling of an exhibition room, and an arrangement of especially devised projecting lenses and a continuous photographic film, with the necessary mechanism for blending and adjusting the projected sections of the picture in one complete cycloramic view). W Elec–Nov. 16. 900 w.

*2600. The Magnetic Field of a Rectangular Coil. G. M. Minchin (Showing how to calculate practically the component of magnetic force parallel to the axis of a coil of any dimensions at any point in space, and also the value of the potential due to any flat rectangular coil). Elect'n–Nov. 8. 2200 w.

*2601. The Magnetic Force of Any Point in a Plane Due to Electric Currents. Alexander Russell (An interesting graphical method, easily applied in practice with perfectly satisfactory results). Elect'n–Nov. 8. 800 w.

2605. The Durability of Porcelain as an Insulator. James Pass (In favor of its use, and cautions regarding quality). Elec Eng–Nov. 20. 1200 w.

2606. Canal Improvements and the Lamb Motor on the Erie Canal. Ill. (A description of this electric motor and its operation). Elec Eng–Nov. 20. 1000 w.

*2635. The Behavior of the Carbon Brush on the Commutators of Direct Current Power Generators. Harris J. Ryan (Descriptive of the manner the carbon brush takes the current off the commutator so that it is unnecessary to have the brushes moved from point to point with every variation of load in order to avoid sparking). Sib Jour of Engng–Oct. 1100 w.

2649. Good Regulation and the Shaft Governor. Ill. E. T. Adams (A consideration of the problem of securing good regulation from a shaft governor. The directions are written especially for the men actually in charge of a plant). Elec Wld–Nov. 23. 4200 w.

2650. Theory of Dimensional Formulas. Percy H. Thomas (An interesting contribution to this subject). Elec Wld–Nov. 23. 1700 w.

2651. Armature Winding and Connecting Considered as a Mathematical Problem. Ill. Harrison H. Wood (The writer has endeavored to develop the problem as a purely mathematical one, paying no attention to practical methods and devices made use of in winding and connecting, nor to the relative advantages of different methods, where such exist, of grouping the conductors and of connecting them to the commutator). Elec Wld–Nov. 23. Serial. 1st part. 1800 w.

2652. The Inefficiency of the Direct Methods of Converting Heat into Electrical Energy. Leon Le Pontois (Paper read before the Engs. Soc. of W. Penna. The writer's reasons for believing that the most economical solution of the problem lies in the construction of a more perfect heat engine). Elec–Nov. 20. Serial. 1st part. 3000 w.

2654. The Department of Electricity at the Atlanta Exposition. Luther Stieringer (From *Dixie*. An account of exhibits with remarks on advances made since 1893). Elec–Nov. 20. 1200 w.

*2669. The Simple Transformer Diagram. Frederick Bedell (The production of an electromotive force in the secondary. The essential relations between the various quantities involved in the simple transformer). Sib Jour of Engng –Nov. 2500 w.

†2701. The Rating and Behavior of Fuse Wires. Ill. W. M. Stine, H. E. Gaytes, and C. E. Freeman (Paper read before the Amer. Inst. of Elec. Engs. with discussion. Investigations of fuse wires. The experiments cover the entire subject and the results are presented in tabulated form, with numerous diagrams, illustrating curves of sensitiveness, curves of fusing points, and curves of fatigue, Seven fundamental conclusions were announced and discussed). Trans Am Inst of Elec Engs–Oct. 7500 w.

*2710. The History of a Great Electrical Company (Some interesting information concerning the past history and future projects of the Allgemeine Elektricitäts-Gesellschaft, Berlin, obtained in an interview with Herr Rathenau). Elec Rev–Nov. 15. Serial. 1st part. 1200 w.

*2737. The Carborundum Works at Niagara Falls. Ill. Orin E. Dunlap (Description of the manufacture of carborundum as now carried out). Elect'n Nov. 15. 1800 w.

2784. Insulation of Overhead and Underground Circuits Having a Difference of Potential of 2000 Volts and Over. William Brophy (Abstract of a paper read before the Electric Potentials, Boston. The author believes that all high potential circuits should be placed underground, but as they are not so placed, he deals with the question of how to construct and insulate them). Elec–Nov. 27. 2200 w.

†2850. Professor Forbes on "Harnessing Niagara." Ernest A. Le Sueur (A severe criticism of Prof. Forbes' recent article in Blackwood's Magazine in which the truth of some of the statements therein made are denied, and the propriety of the position assumed by the author in the article criticised, is questioned). Pop Sci M–Dec. 2700 w.

*2882. Some Observations upon Electrical Engineering Progress in Europe. Charles T. Rittenhouse (An account of what appeared to the writer some of the chief features of construction and operation). Elec Pow–Dec. 4500 w.

*2883. Electrical Equipment of Modern Office Buildings. Joseph Sachs. (An explanation of the various applications of the electric current considered essential in such buildings). Elec Pow–Dec. 2600 w.

*2900. The Hysteresis of Iron in an Alternating Magnetic Field. Francis G. Baily (Experiments undertaken to prove whether the same law of hysteresis holds in a rapidly alternating field as in one of very slow change, and the curve of hysteresis and induction show a flexure, reaching a maximum, and after that remaining constant. Concluding that the hysteresis of iron arrives substantially at a maximum when the iron becomes saturated, and that the function expressing the hysteresis in terms of the magnetic condition of the iron should depend not on induction, but on the intensity of the magnetization, with at most a small correction in terms of the former). Elect'n–Nov. 22. 2500 w.

*2907. Development of the Electro-Depositions of Gold in the Transvaal. Emile Andreoli (Facts and figures taken from a recently published report of the Rand Central Ore Reduction Co., Limited, showing surprising progress during the last year). Elec Rev, Lond–Nov. 22. 1700 w.

2914. The New York Industrial Building, Where the Grand Electric Light and Railway Exhibit of 1896 Will be Held. Ill. (Details of construction and arrangement). Elec–Dec. 4. 2000 w.

2915. Variation in Electrical Conductivity of Metallic Wires in Different Dielectrics. Fernando Sanford, in the *Physical Review* (Giving the results of careful experiments by the writer and other investigators). Elec-Dec. 4. Serial. 1st part. 1600 w.

2934. How Shall We Insulate Our Overhead Wires? (Editorial remarks with extracts from contributions by William Brophy and B. J. Arnold). W Elec–Dec. 7. 4200 w.

2951. Formulas for Winding Magnets. I. A. Taylor (Method for finding the size and number of turns of wire on a magnet). Elec Wld-Dec. 7. 500 w.

2952. Hydro-Electrothermic Heating. Paul Hoho (Treating of the production of heat by the direct conversion of electrical energy. Description of systems and industrial applications). Elec Wld–Dec. 7. 4000 w.

*2973. Which Electrolytic Methods Can Be Used with Advantage in Analytical Practice? Dr. Bernhard Neumann (From *Zeitschrift für Elektrochemie*. A condensed article which contains much valuable information). Elect'n–Nov. 29. 4000 w.

*2974. The Crompton Potentiometer: Its Use and Capabilities. W. C. Fisher (Notes and suggestions upon the working and capabilities of this special type of instrument). Elect'n –Nov. 29. Serial. 1st part. 2800 w.

*2994. The Deflected Arc System of Electric Welding. Ill. (Complete detailed description of samples of work performed by the Zerener system). Engng–Nov. 29. 600 w.

INDUSTRIAL SOCIOLOGY

Plutocracy and Paternalism.

PROFESSOR LESTER F. WARD, in *The Forum* for November, gives the above title to an article which will interest students of sociology, whether they can accept his views or not. At the outset he asserts the impossibility of making anything more than an approximation to "an unbiassed analysis of the true meaning of these terms in their relation to the existing state of affairs"; and he evidently leans toward the paternalistic side. He states the proposition that, while on general principles wealth can easily be proved not to be a measure of the worth of those who possess it, "justly or unjustly" it has been established as a standard of worth by society. This is the evolutional result of "universal competition . . . where the fittest to survive is always the one who can gain possession of the greatest amount of this world's goods. It has, therefore, a rational basis, a substratum of truth on which to rest. We are chiefly concerned with it here as a fact. It is universal. Those who most thoroughly condemn it are influenced by it. The force that works against it in society is not the absence or weakness of the sentiment itself, but another and wholly dissimilar feeling,—*viz.*, sympathy. This sentiment is not rational, but illogical, as shown by the fact that men give alms to satisfy temporary want rather than opportunity to supply permanent needs. But of the other sentiment, which may be called 'plutolatry,'—the worship of wealth,—even the victims show traces, and, in denouncing the rich, they unconsciously attribute to them a personal dignity proportional to their wealth." This regard for wealth is, therefore, not an evanescent social development. "Wealth gives not only ease, plenty, luxury, but, what is infinitely more, the respect of all and the envy of the less favored. It gives, in a word, superiority; and the strongest craving of man's nature is in one way or another to be set over his fellows. When all this is considered, the futility of the proposal of certain reformers to eradicate the passion for proprietary acquisition becomes apparent. It may be assumed that this passion will continue for an indefinite period to be the ruling element of the industrial state. That it has done and is still doing incalculable service to society few will deny. That it may continue to be useful to the end of our present industrial era will probably be admitted by all but a small class."

The accumulation of wealth implied in the term "plutocracy" is not what Professor Ward deprecates. The mere accumulation of (even colossal) wealth cannot, in his opinion, become a social evil, except in one way; its transmission to heirs may in time produce "a non-industrial class in perpetuity." However, such a result may, he thinks, be prevented by limiting the power of bequest. Professor Ward does not seem to perceive that such a limitation would have to be accompanied by a legal limitation of gifts during life, to make it at all effective. Such a curtailment of personal liberty would not be practicable. It would be as easy to limit the personal acquisition of wealth, which he regards as a blessing. Moreover, it is within the non-industrial class that the largest acquisitions of wealth are made, if the term "industrial class" properly includes only producers of wealth. Production and accumulation are quite distinct, and a good thinker should not confuse their meaning.

As to paternalism, the author says that "literally. . . . paternalism in government would be restricted to cases in which the governing power is vested in a single person, who may be regarded as well-disposed and seeking to rule his subjects for their own good, as a father governs his children. But a ruling family, or even a large ruling class, may be supposed to govern from similar motives. In either case the governed are not supposed to have any voice in the matter, but are cared for like children by the assumed wisdom of their rulers. How far from true paternalism is anything that exists in this or any other civilized country to-day may, therefore, be readily seen. No one will claim that there is any danger, in a representative government with universal suffrage, of any such state being brought about. This shows at the outset that the term is not used in its original and correct sense, but is merely borrowed and applied as a stigma to certain tendencies in republican governments which the users of it do not approve. What are these tendencies? In general, it may be said that they are tendencies toward the assumption by the State of functions that are now entrusted to private enterprise."

Without any limit to these tendencies, the result would be a Socialistic system of government. Were the State to relinquish functions it has assumed, there would be an end of government. The moderate view reduces the question to one of policy, rather than of principle to be carried out to its extreme and logical application. There are dangers in both directions, if pursued too far.

"If we look for precedents and historical examples, we find great diversity. If we take the question of government telegraphy, we find that the United States is almost the only country in the civilized world that has not adopted it, while the reports from other countries are practically unanimous in its favor. That such a movement should be called paternalism is, therefore, quite gratuitous, and must spring from either pecuniary interest or unenlightened prejudice. From this on, up to the question of abolishing the private ownership of land, there is a multitude of problems, presenting all shades of difference in the degree to which the principle of State action is to be applied in their solution. They need to be fearlessly investigated, coolly considered, and wisely decided in the true interests of the public. It was not the purpose of this article to discuss any of these questions, but simply to mention them in illustration of the popular use of the term 'paternalism.' It is clear that that term is employed solely to excite prejudice against the extension of the functions of the State, just as the term 'plutocracy' is used to arouse antagonism to the wealthy classes. The words have in these senses no natural meaning, and, with intelligent persons, should have no argumentative weight."

That each individual will seek his greatest gain is enunciated as the "first law of economics"; and it is regarded as "both natural and right" that he should do this "rather irrespective of the rest of the world." This was true in the primitive state of mankind, and it is equally true now, "when business shrewdness is supreme." Government, originally "occupied solely with abuse caused by brute force," is still occupied with this class of abuses considered "relatively trifling as compared with advantage gained by cunning, by superior knowledge,—if it be only of the technicalities of the law,—and which, though not (legally) a crime, may be in spirit as bad as that of highway robbery, and its consequences a thousand times worse."

This brings us to the nub of Professor Ward's paper.

He regards society as suffering from under-government, and government itself as "to-day powerless to perform its original function of protecting society." Artificial conditions have nullified "the operation of the natural law, on the lower plane." Indeed, the effect is reversed, and, instead of developing strength, either physical or mental, through activity incident to emulation, it tends to parasitic degeneracy through the pampered idleness of the favored classes. Social conditions "embodied in law," and largely consisting of statute law, supplemented by judicial decisions, often immemorial, and belonging to the *lex non scripta*, intended to make men secure in their possessions and safe in their business transactions, have, "owing to entirely changed industrial conditions, become the means of throwing unlimited opportunities in the way of some, and of barring out the rest from all opportunities."

"And thus we have the remarkable fact,

so persistently overlooked in all the discussions of current questions, that government, which fails to protect the weak, is devoting all its energies to protecting the strong. It legalizes and promotes trusts and combinations; subsidizes corporations, and then absolves them from their obligations; sustains stock-watering schemes and all forms of speculation; grants without compensation the most valuable franchises, often in perpetuity; and in innumerable ways creates, defends, and protects a vast array of purely parasitic enterprises, calculated directly to foster the worst forms of municipal corruption. The proofs of each one of these counts lie about us on every hand. Only those who are blinded by interest or prejudice can fail to see them.

"There is no greater danger to civilization than the threatened absorption by a few individuals of all the natural resources of the earth, so that they can literally extort tribute from the rest of mankind. If half a dozen persons could get possession of all the bread-stuffs of a country, it would justify a revolution. Fortunately, from the nature of this product, this is impossible, although long strides in that direction have from time to time been taken. But it is otherwise with some other products, which, if less indispensable, are still among the modern necessaries of life. All the petroleum of this country is owned by a single trust. If men could not live without it, there is no telling how high the price could be raised. Nothing limits it but the question how much the public will pay rather than do without. That indispensable product, coal, has well-nigh reached the same stage through the several railroad combinations that now control it. That which costs sixty cents to mine, and as much more to transport, cannot be obtained by the consumer for less than five or six dollars. Does it speak well for the common sense of a great people that they should continue to submit to such things? There seems to be no remedy except in the power of the nation."

The conclusion is that government protection should be extended as rigidly to the property of the poor as to that of the rich, and that the paternal solicitude of the government for trusts and monopolies should be directed to the interests of the general public. "If we must have paternalism, there should be no partiality shown in the family."

Employer and Employee Under the Common Law.

THE compilation prepared for the November *Bulletin of the Department of Labor*, by Victor H. Olmstead and Stephen D. Fessenden, is one of the most valuable documents supplied by the department during the present year. In it are contained the "principles, usages, and rules of action . . . . which have grown into use by gradual adoption, without legislative authority, and have received, from time to time, the sanction of the courts of justice," and which now constitute the common law of the relations existing between employers and employed. We shall endeavor, in what follows, to make such an abstract of this paper as will furnish the reader with the most important principles still recognized as not having been altered by legislation, quoting first the definitions of "master" and "servant" as presented by the authors. "A master is variously defined as one who has in his employment one or more persons hired by contract to serve him either as domestic or common laborers; one who has the superior choice, control, and direction, whose will is represented not merely in the ultimate result of the work in hand, but in all its details; one who is the responsible head of a given industry; one who not only prescribes the end, but directs, or may at any time direct, the means and methods of doing the work; one who has the power to discharge; a head or chief; an employer; a director; a governor.

"A servant is one who is employed to render personal service to his employer otherwise than in the pursuit of an independent calling, and who, in such service, remains entirely under the control and direction of the latter."

The relation is established by contract, which may be either written or verbal, express or implied, when both parties are legally qualified to make contracts. The contract may be entered by either party through the action of any duly authorized agent.

The term of employment, in the absence of an express agreement, is the term for which the wages rate is stipulated. Thus a workman paid by the day is employed for a day; one paid by the week is employed for a week, etc. If one thus employed claims that any change in the contract has been made in this particular, the burden of proof of such an allegation rests upon him.

A contract for a term longer than one year must be in writing, and signed by the party against whom it is sought to be enforced. In the absence of an express contract, a servant may recover such compensation as he can show he had the right to expect for his service under the circumstances of the case.

A master is bound to furnish the employment he contracts to furnish. A workman employed by the day, week, month, or year, may, in the absence of express agreement, demand his pay accordingly,—that is, daily, weekly, monthly, or yearly; daily, weekly, or monthly wages imply payments each day, week, or month, when other terms are not agreed upon. A husband may contract for the labor of a wife, and may collect her wages unless they are separately claimed by her, but a wife is not responsible for the wages of a servant employed by her husband. Disputes as to amounts of compensation are questions for a jury. When not otherwise stipulated, wages must be paid in cash, and directly to the servant. Incompetence justifies a discharge before the expiration of a term of service; but the incompetency must be clearly shown. When discharged before the end of a term agreed upon, the employee may recover the amount stipulated for the remainder of the term, less the amount earned, or the amount that, with reasonable effort to obtain work, he could have earned, during the period. When wrongfully discharged, he may proceed to recover pay for the remaining part of his term of employment as follows:

"(1) He may sue at once for the breach of contract, in which case he can only recover his damages up to the time of bringing the suit; (2) he may wait until the end of the contract period, and then sue for the breach; (3) he may treat the contract as existing, and sue at each period of payment for the wages then due; (4) he may treat the contract as rescinded, and sue immediately for the value of his services performed, in which case he can only recover for the time he actually served."

A number of persons may agree with each other that they will not work for, or deal with, certain persons provided no unlawful purpose is sought to be carried out by such an agreement, in which case such an agreement would be in itself unlawful.

"On the other hand, a combination of employees having for its purpose the accomplishment of an illegal object is unlawful; for instance, a conspiracy to extort money from an employer by inducing his workmen to leave him and deterring others from entering his service is illegal; and an association which undertakes to coerce workmen to become members thereof, or to dictate to employers as to the methods or terms upon which their business shall be conducted, by means of force, threats, or intimidation interfering with their traffic or lawful employment of other persons is, as to such purposes, an illegal combination.

"Unlawful interference by employees, or former employees, or persons acting in sympathy with them, with the business of a railroad company in the hands of a receiver, renders the persons interfering liable to punishment for contempt of court.

"It has been held, however, that employers in separate independent establishments have no right to combine for the purpose of preventing workmen who have incurred the hostility of one of them from securing employment upon any terms, and by the method commonly known as blacklisting debarring such workmen from exercising their vocation, such a combination being regarded as a criminal conspiracy.

"Employers are ordinarily responsible

to employees for injuries resulting from negligence on the part of the employer, provided the employee does not contribute to the risk by his own negligence. Employers must furnish reasonably safe tools and machines, and not in any way expose their workmen to unusual dangers.

"Workmen in the employ of a common master, subject to the same control, paid from a common fund, and engaged in promoting a common object, are in common law fellow-servants. A master is not ordinarily liable for injuries to a workman received through the negligence of a fellow-servant, though circumstances may in some cases make such negligence his own; in the latter case he incurs liability."

Sundry Labor Questions.

UNDER the above title, the *Journal of Gas Lighting*, a technical paper which discusses sociological subjects with exceptional ability, reviews (Oct. 29) the present industrial situation in England. While the improvement in general industry has brought with it "the inevitable concomitant strikes for higher wages by some organizations of skilled workmen, the members of the coal miners' unions, and other followers of rough trades," have enough to do to make ends meet at the close of each week. And while the English press very generally is commenting upon the strikes and lamenting the embarrassments to trade which they have caused, profit-sharing, a system which our contemporary has been strenuously advocating as a sovereign remedy for strikes, is scarcely at all discussed in other journals. This indicates a want of appreciation of arguments favoring profit-sharing, or, what is more probable, a mistrust of its practicability as an industrial system under present commercial conditions.

Another phase of the situation noticed is "that, when it comes to a question of striking or not striking, the old unions of skilled workers are quite as likely to take it fighting as the 'new' unions, which are supposed to differ from them greatly in many respects. . . . We have not been able to forget the performances of the Sheffield trade unions of the last generation,—unions of skilled workers surely, if such could have been found anywhere,—and cannot believe that organizers of close societies avowedly existing for the sole benefit of their members will ever be squeamish as to the means they employ to gain their ends. It stands to reason that the responsible managers of trade societies with money as well as credit to imperil by any indulgence in lawlessness will be chary of encouraging violent counsels in regard to the conduct of disputes with employers. Moreover, the more perfectly they succeed in getting within their membership all the available followers of trades which cannot be learnt in an hour by the first comer, the less will be their temptation to practise other than waiting tactics for bringing disputes to an end. All the same, when it is brought to ultimate analysis, the way in which the old trade unions apply the principle of unity in practice will be found to differ very little, if at all, from that favored by the new unions. It should not be overlooked by those who reflect upon this similarity of methods in trade unionism that some of the most savagely conducted of the conflicts of new unions were carried on under the auspices of men who had learnt in an old trade union of what spirit the creature really is."

The new unions are very severely—we had almost written "savagely"—criticised. They are stigmatized as "so many mobs, influenced, as mobs are influenced, by power of tongue and lung; and professional Socialists are apt at this kind of thing. The old trade societies are largely composed of respectable men,—family men and men with money savings. It is useless to dangle collectivism as a bait before such hard-headed as well as horny-handed customers. The leaders they are prepared to follow are not street-corner spouters, but men like themselves, with a bit of money laid by, and a keen eye upon the means of increasing the store. Yet does anybody think that such men will shrink from fighting their employers to the last gasp, if they are convinced that their wages ought to be a halfpenny an hour more? Not they; nor are they men to stick overmuch at the adoption of any means for gaining their end. They will not stone a recalcitrant employer, or go whining to a lord mayor for help before they have been out a month; but there is that in them which would render their company undesirable by a 'free laborer' of their own class when they had grown desperate."

The words "free laborer," used to distinguish a man not enslaved by a union from one so bound, are particularly forcible here.

The sympathy of the modern philanthropist is more enlisted by the later troubles of the "new" unions than by those of the "old," because the latter almost uniformly involve only "questions of work or of wages, or of working hours," when their strikers are not ordered out "on principle," the latter being something which does not concern the general public.

"The philanthropist may regard with vague benevolence the spectacle of a body of comparatively well-to-do artisans in conflict with their employers upon the question of whether they should be paid a halfpenny an hour more or less, or whether the factory bell should ring at this or that hour. He may entertain a general impression that the men are probably in the right of it; but, so far as he and his class are concerned, the issue is no concern of theirs. There is nothing to be made out of it by an impartial 'conciliator,' who would have to begin by confessing that the considerations bearing upon the point at issue were too technical for him to understand, much less to pronounce judgment upon. But when it is a case of a whole industrial population of poor fellows claiming no more than a 'living wage,' which the ogre-like employers do not see their way to paying,—ah! then the philanthropist (at other people's expense) sees his chance; and usually, like Bret Harte's hero, he 'goes for it then and thar.'"

New York is cited as a specimen municipality wherein this kind of philanthropy has resulted in a rate of wages "fixed by law at about double current rates." Our contemporary, however, in attributing this to philanthropy, seems to have overlooked the influence which our corrupt municipal government has had in fixing rates of wages, although the expression "philanthropist at other people's expense" may perhaps be intended to cover that kind of politician, who, if a philanthropist in any sense of the word, is always such at other people's expense and for his own profit.

A powerful argument in favor of profit-sharing is concluded as follows: "Apart from this aspect of militant trade unionism, and reverting to the question of rate of wages, it is obvious that, where profit-sharing exists, there can be no temptation to strike for increased pay supposed to be warranted by an improved state of trade. If the antecedent condition existed, it would show itself at the proper time in heightened profits for all the partners; and the funds of the unions would not be spent in testing for the fact by a method as wasteful as the legendary Chinaman's expedient of burning down his house whenever he desired to roast a pig."

Prospects of American Export Trade with Japan.

If a correspondent of the *Chicago News*, Mr. W. Curtis, has gained correct views by his visit to the exposition at Kyoto, the prospects of a future export trade of American general merchandise to Japan are not flattering. The exposition, according to Mr. Curtis, demonstrates the fact that, as expert imitators, the Japanese are in the front rank. He says that the exposition contains in its department of manufactures a sample of almost everything that enters into the wants of civilized men, and most of the articles are exact reproductions of inventions still protected by patents in Europe and the United States.

Japan has hitherto refused to enter into patent and trade-mark treaties, and gives a good reason for her refusal. "The United States and the European powers have refused to recognize Japan as a civilized nation. They have refused to submit their subjects to the protection of our courts, and have forbidden us to make our own tariff. They insist that their subjects in

Japan shall be tried before their own consuls, under the laws of their own country, because our laws are not good enough for them, and they will not allow us to impose a duty of more than 5 per cent. upon imported merchandise. They blame us for not being willing to make a treaty to protect their patents. Under the new treaties that take effect in 1899, Japan will become a member of the International Patent and Trade-Mark Union, and will give the inventions of foreigners the same protection that its own receive. If that is not satisfactory, our government would be willing to have the new treaties go into effect tomorrow, instead of 4 years hence." This is the explanation of the policy of Japan upon the subject of patents, as given by the chief examiner in the Japanese patent office.

Among articles imitated successfully in Japan Mr. Curtis names the following: Hoe perfecting printing presses—copied, name and all; type-setting machines; printers' supplies; Fairbanks' scales; Mason and Hamlin organs; American locks; Pears' soap; Beecham's pills; Bass's ale; Porter's stout; Milwaukee export beer; Eagle brand of condensed milk; Armour's compressed beef; patent safety razors; lamp burners; etc. Some of these articles, it is stated, are selling at one-third the price they bring in the United States.

Physics and Sociology.

THE inadequacy of the methods of physical science when applied to sociological science is well pointed out by Mr. W. H. Mallock in the *Contemporary Review* for December. There has of late been visible an effort to bring sociology under the same methods as those by which physical sciences are studied. "Social science," says Mr. Mallock, "differs from physicial science, not only in having access to two orders of phenomena, whereas physical science has access only to one; but also in the fact that this second order of phenomena, to which physical science offers nothing analogous, is for social science the more important of the two, and demands from it a study concurrent with, and similar to, that bestowed upon the first. . . . When we attempt to apply to the social world these methods and theories which we have applied to and learned from a systematic study of the physical world, and which form for us the type and model of what we mean by science, we are obliged by the very principles of that physical science itself, to do certain things which physical science does not do, and to recognize that, whilst the procedure which it suggests to our intellect may be correct, the model which it actually offers us is altogether inadquate."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Industrial Sociology in the American, English and British Colonial Technical Journals—See Introductory.

*2464. Representative Money and Gold Exportations. Horace White (Showing the results of fiat money, and that all the money issued by the United States government, except gold and national bank notes, is fiat money, whether metallic or not). Eng Mag–Jan. 3500 w.

*2470. A Piece-Rate System and Shop Management. Fred W. Taylor (Favoring payment of labor at rates determined by analysis of the labor, and so differentiated as to give the superior workman more than the usual rate and the inferior workman less than the usual rate). Eng. Mag–Jan. 4300 w.

2566.—$1. The Custody of State Funds. E. R. Buckley (An explanation of the two methods employed by the United States Government in keeping the public money—the "bank depository system" and "the independent treasury system." Concluding that there are good reasons for discontinuing the latter system, while the former meets with nearly universal approval). An of Am Acad–Nov. 2800 w.

2567.—$1. Railway Departments for the Relief and Insurance of Employés. E. R. Johnson (A study of the railway relief department, the motives which prompted the establishment, the different organizations and history, the pension and superannuation feature, the savings feature, results accomplished and objections raised, special advantages, &c. Concludes that it is an institution of undoubted benefit to the employés, the railway companies, and the public). An of Am Acad–Nov. 14000 w.

†2607. The Improvement of Working-Class Homes. H. M. Bompas (The evils of the present system of taxation in England pointed out and their remedy suggested, and difficulties conceded). Fortnightly Rev–Nov. 4000 w.

We supply copies of these articles. See introductory.

*2663. Labor Statistics (Review of the 2d Annual report of the Labor Department of the Board of Trade). Engng-Nov. 8. 2300 w.

2687. The Relation of the Federal Courts to Organized Labor. William H. Taft (A labored and learned answer to the charge, admitted to be true, that judicial action has been, and is, much more efficient to restrain labor excesses than corporate evils and greed. The justification is found in the nature of the two evils. Physical force is involved in the one and not in the other. The writer regards corporate wrong as in its nature almost wholly beyond the reach of the courts in the United States). Ry Rev–Nov. 16. 2400 w.

*2714. The Latest Labor War (Discusses the dangers of trade unionism in trades which, like transportation, gas-lighting, ship-building, telegraphy and postal distribution, are wholly or partly in the nature of a public service). Jour of Gas Lgt–Nov. 12. 2000 w.

*2759. Conditions for American Commercial and Financial Supremacy. Paul Leroy-Beaulieu (The commercial and financial situation is viewed from the European standpoint and found so inexplicable as to excite surprise in the minds of Europeans. The weaknesses of the monetary system in the United States are pointed out and suggestions for improvement are given). Forum–Dec. 5500 w.

*2760. The Nature of Liberty. W. D. Howells (This article takes the ground that the dream of infinite liberty is the hallucination of the anarchist, that is, of the individualist gone mad; and that the moment liberty in this sense was achieved, we should have the rule, not of the wisest, not of the best, not even of the majority, but of the strongest, and no liberty at all. To be free we must be equals in opportunity and safety). Forum–Dec. 3800 w.

*2771. Cotton Mills in the Southern States (Described by an English tourist, who appears to be a practical cotton manufacturer and able to take in the full significance of the southern cotton manufacturing industry). Mach, Eng–Nov. 15. 1300 w.

*2777. Tariff Changes in Italy (A list of articles on which the duties have been altered). Bd of Tr Jour–Nov. 700 w.

*2778. Customs Tariff of Newfoundland (A statement of the rates now levied on merchandise imported into Newfoundland). Bd of Tr Jour–Nov. 2000 w.

*2779. Tariff Changes and Customs Regulations (Russia, Norway, Germany, Netherlands, East Indies, France, Portugal, Spain, Italy, Roumania, United States, Brazil, Argentina, &c). Bd of Tr Jour–Nov. 4500 w.

2785. Employer and Employee under the Common Law. Victor H. Olmsted and Stephen D. Fessenden (First number treats of master and servant definitions; the relation, its creation and existence; the contract of service; combinations and coercion of servants; employer's liability for injuries of employees). Ir Age–Nov. 28. Serial. 1st part. 3500 w.

2812. The Mint Report (An editorial review of the report of the director of the U. S. mint). Bradstreet's–Nov. 30. 700 w.

2813. The Foreign Speculative Outlook (Reviews predictions made in the London *Statist*, the conclusion of which is that there will soon be recovery in the markets for mining shares, unless the eastern political situation grows dar).ker Bradstreet's–Nov. 30. 1000 w.

2814. Postal Abuses and Reforms (Reviews the working of the Postal Department for the fiscal year ending June 30, 1895). Bradstreet's–Nov. 30. 1000 w.

2815. Development of Labor Statistics (States not having and those having such bureaus. Review of Bulletin of the National Department of Labor). Bradstreet's–Nov. 30. 800 w.

2816. Manufacturers in Massachusetts (Industrial statistics). Bradstreet's–Nov. 30. 1200 w.

*2822. The Trade of the World (Statistics of I. Exports of different countries in 1883 and 1893. II. Value of the imports received into the principal countries from the United Kingdom, Germany, France and the United States. III. Value of the exports of the principal countries in 1893 to the United Kingdom, Germany, France and the United States, from which it is concluded that notwithstanding the fears expressed by some portions of the British industrial press, the situation of British trade is satisfactory from many points of view). Ir & Coal Tr Rev–Nov. 22. 1100 w.

†2849. Principles of Taxation. David A. Wells (First part outlines the exceptional circumstances under which the author has prosecuted his studies and investigations, dating from the publication, in 1864, of his book "Our Burden and Our Strength"—which became one of the current publications of the war period. Subsequent numbers will deal with the subject under proper and consecutive subdivisions). Pop Sci M–Dec. Serial. 1st part. 5800 w.

†2852. Has Immigration Increased Population? Sydney G. Fisher (The author seeks to show that the population of the United States is now less than it would have become through increase of the native population had it continued to increase at the rate it did through fifty years following the Revolution of the colonies, and had immigration been wholly prohibited. It dates the first decline in the rate of native increase from the year 1830, when the effects of immigration were first seriously felt). Pop Sci M–Dec. 5500 w.

†2887. Strlkes and Lockouts in the United States from January 1, 1881, to June 30, 1894. (Tabulated statements compiled from the third and tenth annual reports of the U. S. Commissioner of Labor, with deductions and comments). Bul of Dept of Labor–Nov. 6500 w.

†2888. Strikes and Lockouts in great Britain and Ireland in Recent years (Tabulated Statements compiled from annual reports of the British Board of Trade, with comment, explanation and deductions). Bul of Dept of Labor–Nov. 2000 w.

†2889. Strikes in France in Recent Years (Tabulated statements compiled from the French Office du Travail, Statistique des Grèves et des Recours à la Conciliation et à l'Arbitrage Sur-

venus Pendant l'Année, 1864, with explanations, comments and deductions). Bul of Dept of Labor–Nov. 1000 w.

†2890. Strikes in Italy in Recent Years (Tabulated Statements derived from the Statistica degli Scioperi avvenuti nell' Industria e nell' Agricoltura durante gli anni 1892 e 1893, with explanations, deductions and comments). Bul of Dept of Labor–Nov. 500 w.

†2891. Strikes in Austria in Recent Years (Tabulated summaries and statements compiled from Vol. XI of the Foreign Reports of the British Royal Commission on Labor, with explanations and comments). Bul of Dept of Labor–Nov. 500 w.

†2892. Private and Public Debt in the United States. George K. Holmes (Compiled from various sources, chiefly from Bulletins and final reports of the XIth Census, Poor's Manual of Railroads, the Manual of American Waterworks, reports of the Massachusetts gas and electric light commissioners, and reports of the Comptroller of the Currency, and presented in tabulated form). Bul of Dept of Labor–Nov. 3800 w.

†2893. Recent Reports of State Bureaus of Labor Statistics (A digest of the reports of the state bureaus of labor statistics in Connecticut, Indiana, Michigan, Minnesota, Missouri, and Wisconsin is given, and will be followed, in subsequent numbers, by similar presentations from the reports of the bureaus in other states. As far as possible quotations have been made from the results of the original investigations conducted by the different bureaus). Bul of the Dept of Labor–Nov. 8500 w.

†2894. Report by Miss Collet on the Statistics of Employment of Women and Girls in England and Wales (Digest of a report prepared for the British Board of Trade and based upon information contained in. 1. Returns made to the labor department in 1894 by cotton, woolen, and worsted manufacturers as to the employment of married women in their mills—especially procured for this report. 2. The statistics of occupations of women and girls at different ages in urban sanitary districts with over 50,000 inhabitants—compiled from the census sheets. 3. The published returns of inquiries recently conducted on the required scale and according to uniform methods to be found in the census returns of occupations in 1891, and in the board of trade returns of rates of wages in textile trades in 1886). Bul of the Dept of Labor–Nov. 4200 w.

†2895. Employer and Employee under the Common Law. Victor H. Olmsted and Stephen D. Fessenden (The relation existing between employers of labor and their employees, as governed by common law, in the absence of legislative enactments are herein presented in a digest compiled from various authoritative sources). Bul of the Dept of Labor–Nov. 7000 w.

†2898. Results of the Behring Sea Arbitration. John W. Foster (A defence of the policy of international arbitration. Examining the origin and complications in the controversy named, and defending the course taken by our government). N Amer Rev–Dec. 4200 w.

†2899. Our Benefits from the Nicaragua Canal. Arthur Silva White (A consideration of the political aspect, and the co-related conditions of international commerce). N Amer Rev–Dec. 2500 w.

*2916. Should the Government Control the Telegraph? I. Why the Government Should Own the Telegraph. Richard T. Ely. II. The Legal Aspect of the Telegraph and Telephone Services—Essential Parts of an Efficient Postal Service. Justice Walter Clark (Both articles favor government ownership, and set forth the advantages. Reference is made to other countries showing good results of such ownership). Arena–Dec. 3800 w.

*2917. Equality of Opportunity: How Can We Secure It? James L. Cowles (Considering the making of the railways, tramways, telegraph and telephone systems of the country, free to the use of the whole people in their ordinary transactions, and supporting these great public works by the ordinary forms of taxation. The writer does not advocate so radical a change immediately, but his proposition is to work toward this by bringing the systems of public transportation and communication under the control of the post office, making ordinary travel and the ordinary use of the telephone and telegraph free, and determining the tolls charged for special services, etc. on the postal principle, adopting the lowest rates now charged for the shortest distance as the standard rate for all distances within the United States). Arena–Dec. 6000 w.

*2961. The Multiple Standard. Henry Winn (An effort to show the chief vices of money based on gold, or gold and silver, and that their remedy lies in demonetizing both and adopting the multiple standard). Am Mag of Civ–Dec. 8500 w.

*2962. The Labor Movement and the New Labor Party. H. W. Boyd Mackay (The writer claims to set forth the feelings and aims of the party. The three direct objects of the movement are given: (1) To secure to every one constant employment. (2) To secure to every one reasonable pay. (3) To secure to every one adequate leisure). Am Mag of Civ–Dec. 1800 w.

*2963. Evolution of a Wage-Standard. R. L. Bridgman (A sympathetic discussion of the subject tending to show that we are surely advancing toward that system of justice which will insure to the contributing parties a reward according to their contribution to the product). Am Mag of Civ-Dec. 6500 w.

*2964. Legal Regulation of Occupations in the State of New York. Louis Dow Scisco (Tracing the development of legislation affecting occupations). Am Mag of Civ–Dec. 2000 w.

*2965. Funding the National Debt. A Business Man's Plan. William A. Amberg (The steps to be taken and advantages of the plan). Am Mag of Civ–Dec. 1500 w.

2981. The Recovery in "Kaffirs" (Discusses the sudden turn in the market for mining shares, and its probable industrial and financial causes and significance). Bradstreet's–Dec. 7. 850 w.

MARINE ENGINEERING

Evaporative Power of the Belleville Boiler.

DISCUSSION of the merits and demerits of this boiler has been so active of late in marine circles that the following data, obtained from actual trial of boilers built for the Russian twin-screw steamer Kherson, will be considered important as bearing upon the performance of this much-debated innovation. "The ship," says *The Engineer* (Nov. 8) "is to have twenty-four of these boilers, two of which have been completed and tested at the famous marine engineering works of Maudslay, Sons, and Field. Two of these boilers have been completed, and their evaporative power tested under conditions as nearly similar to those under which they will be operated at sea as it was practicable to arrange on land.

"To enable the trials to be carried out under the nearest approachable conditions attainable on shore to those which would obtain on shipboard, the furnace backs and sides of the two boilers were built up with the same material—fire brick—as would be used when in place in the vessel. With this exception the boilers, when under steam, were subject to the influences of the surrounding atmosphere, and its condition at the times of trial, which were not altogether favorable.

"Each of the boilers tested is made up of eight elements, or tube-sections; a section consisting of twenty tubes of wrought iron, 4¼ in. in diameter outside, and about 8 ft. 6 in. long, the total heating and grate surface in both being 2,946 and 93 sq. ft. respectively. As two boilers only were under test, a temporary uptake and short funnel were fitted, the deficiency of natural draught due to this arrangement being made up by the use of a blast pipe.

"As a precautionary measure, and to ensure that all should be in order for the official trial of Friday, Nov. 1, a preliminary trial was made on the previous Tuesday. This was of six hours' duration; the results attained, which were recorded each hour of the trial,—continued from 11 a. m. till 5 p. m.,—being given in tabular form below.

Trial hours.	Coal.		Water.		Steam.
	Total burnt.	Burnt per sq. ft grate.	Total evaporated	Evaporated per lb. of coal	Boiler pressure lb per sq-in.
	lb	lb.	lb.	lb.	
End of 1st hour .	2,016	21·36	17,700	8·79	200
" 2nd " .	4,032	21·36	36,000	8·93	"
" 3rd " ..	6,048	21·36	55,700	9·20	"
" 4th " ..	8,064	21·36	78,500	9·10	"
" 5th " .	10,080	21·86	90,000	8·92	"
" 6th " .	12,096	21·86	108,000	8·92	"
" 7th " ..	14,112	21·36	126,000	8·92	"
" 8th " ..	16,352	21·66	142,800	8·73	"
" 9th " .	18,368	21·62	160,500	8·78	"
" 10th " ..	20,272	21·48	178,700	8·66	"
" 11th " ..	22,400	21·58	195,700	8·73	"
" 12th " ..	24,104	21·39	212,300	8·80	"

"The deduction derived from these figures will be found, on examination, to give a mean of 9.7 lbs. of water evaporated per lb. of coal consumed and 11.23 lbs. of coal burnt on each sq. ft. of fire grate, the mean steam pressure attained being 197.6 lbs. per sq. in., with a blast pressure of practically 23 lbs., the mean temperature of the feed-water throughout being 64 deg. F.

"The results having been so far very satisfactory, the official trial of November 1, which was of twelve hours' duration, was entered on with confidence. The atmosphere, however, which on Tuesday had been very cold, but dry, was on Friday wet, and heavy-laden with fog at the start, but cleared up later on. At 5.40 a. m., with atmospheric temperature of 50 deg. F., fires were lighted; in 40 minutes the gages showed a pressure of 200 lbs. per sq. in. in the boilers; 10 minutes later, or at 6.30 a. m., the measurement of coal and water—for purposes of adjustment—was commenced, and continued till 8 a. m., during which time 18 cwt. of coal per hour were burnt, with a resultant evaporation of 8.8 lbs. of water per lb. of coal. At 8 a. m. the official trial was commenced, and continued without intermission till 8 p. m., the results at the end of each hour being as shown in the accompanying table, from the figures of which it will be seen that the whole twelve hours of the trial the mean evaporation of the water per lb. of coal consumed was 8.88 lbs., and that the coal burnt per sq. ft. of grate was nearly constant throughout, it ranging from 21.36 lbs. at the start to 21.39 lbs. at the finish, and giving a mean of 21.43 lbs. burnt for the whole time. Throughout the trial the steam pressure maintained was 200 lbs. per sq. in., and the temperature of the feed-water was 54 deg. F. The fuel used was Welsh coal of only average quality, the fires being cleaned at the sixth and tenth hours. To ascertain if the safety-valves of the boilers were capable of dealing with any quantity of steam likely to be produced in them, an accumulation test was made subsequent to the trials; for this purpose the safety-valves were set to lift at 245 lbs. per sq. in. and firing resumed, when coal was burnt at the rate of from 35 lbs. to 40 lbs. per sq. ft. of grate per hour, the maximum pressure recorded by the steam gage during the hour in which the test was continued being 247 lbs. per sq. in. Throughout the twelve hours' trial of the boilers, all the coal weighed was fired, no allowance being made for cleaning or what had found its way to the ashpits through the fire bars."

These tests seem to prove conclusively that the evaporative efficiency of the Belleville boiler is high, the figures being for actual coal supplied to the furnaces, with no deductions for coal falling through the grate. It remains to be seen whether the inherent faults of the boiler, which are notable, will prove to be so great as to offset in practice its steaming efficiency.

Tubulous Boilers in the French Navy.

A PAPER by Assistant Engineer John K. Robison, reprinted from the *Journal of the American Society of Naval Engineers*, in *Engineering* (Nov. 1), gives conclusions derived from personal observations of the practical working of these boilers on vessels of the French navy, in which this type has largely replaced the cylindrical boilers used by other nations in vessels of large size.

Of the much-lauded and much-criticised Belleville boiler the author says: "The extremely small quantity of water in the boiler has made the use of an automatic feed-regulator necessary. This regulator works well when it does work, but fails to work at all often enough to destroy confidence in it. Besides, when the regulator fails to work, serious accidents often result. The amount of feed-water is so small that any failure of the regulator to act is liable to cause the water to disappear entirely from the boiler. The small quantity of water in the boiler likewise causes large variations in the steam pressure, and necessitates a larger pressure in the boiler than at the engines; that is to say, there is a reducing valve between the boilers and the engines."

"The slow circulation of the water causes the tubes to deteriorate very rapidly, if the water is not pure. The tubes of the lowest row are made very thick, but they wear out very rapidly, nevertheless, being bent after fires are lighted under the boilers two or three times.

"The system of circulation of the water causes a great deal of 'priming,' and this cannot be cured even with the use of a complicated set of baffle-plates in the steam drum of the boiler, and with the addition of a separator between the boilers and the reducing-valve. The reducing-valve must also reduce the amount of water in the steam, though it has been seen that this is not the prime object of its use. It has been estimated by engineers who have worked these boilers for several years that the amount of water in the steam at the cylinders is never less than ten per cent.

"The use of the Belleville boilers was said at the outset to be sure to give a great gain in economy of fuel. In fact, many engineers still seem to think that they are not greatly inferior to the Scotch boilers in this respect. The fact is, however, that the arrangement for the combustion of the coal to take place entirely in one place has made the mixing of the gases of combustion very poor. To insure their proper mixing, all the gas from the grate should be brought together at some point before the combustion is supposed to be completed. This would correct the inequalities in the thickness of the fires on different parts of the grate. So very poor is the mixing of the gases in the Belleville boiler that it has been found necessary to have a pump for forcing jets of compressed air in the top of the furnace, forcing the gases of combustion down towards the grate, and so promoting their thorough mixing.

"The absolute necessity of a sure-acting feed-pump has led to the use of a specially-designed pump that will always be sure to act. This result is obtained at the cost of a large amount of steam for the pumps, but the result is so necessary that it has been said that the pump is what makes the boilers."

The boiler and its numerous accessories need frequent repair, but the repairs can generally be made in a shorter time than in the boiler instalment of the older type; and the disadvantage of greater frequency is thus more or less counterbalanced.

The advantages of the boiler most appreciated by the French naval authorities are that its action is rapid in getting up steam; that its weight in proportion to steaming capacity is much less than that of boilers of the cylindrical type; that it is easier to take it out or put it into a ship, necessitating no cutting of decks; and that higher pressures can be carried with more safety than can be carried in the Scotch boiler.

Efforts towards remedying the defects of the Belleville boiler have resulted in the production of the D'Allest boiler, and the Niclausse boiler, and the author thinks that only these three have any chance of supplanting the Scotch boiler for marine use, in large ships, though for torpedo boats and vessels of small size the Normand and the Thornycroft boilers are coming more and more into use. The greatest advantage possessed by the Belleville boiler over the D'Allest is that the arrangement of the tubes in the Belleville permits them to expand more freely; but the D'Allest is somewhat lighter, though it occupies greater floor space than the Belleville. The D'Allest boilers may, however, be forced in steam generation with greater economy than the Belleville. The Niclausse boiler permits the tubes to expand with perfect freedom, and the repairs are all done from the front of the boiler, but it is not so economical a steamer as the D'Allest, which is said to be the only one of the three which equals the Scotch boiler in this respect. Many other interesting facts are given in Engineer Robison's paper, which those who desire to inform themselves further about the merits of these boilers will do well to peruse.

The Hydroplane.

THOUSANDS were amused during the last season by what was known as the 'chute" at West Brighton, a watering. place on Coney island, near New York city. People seated in a boat shot down a steep incline terminating at the surface of a still expanse of water. Upon reaching this surface, the boat with its occupants was lifted bodily from the water, and, jumping over a space of twenty-five or thirty feet., again skipped over another space, and so on, progressing by skips across the still water precisely as a flat stone thrown at an angle with the surface of water skips, till the force with which it is thrown is exhausted,

The bottom of this boat constituted a hydroplane, in the meaning of the term employed by Mr. Harvey D. Williams in *The Sibley Journal of Mechanical Engineering*, in a description of a model constructed by him to demonstrate the possibility of a self-propelling craft constructed to skip over the surface of water, instead of sailing upon it. At first the idea of such a craft might appear absurd; but a moment's reflection will enable the reader to comprehend that this principle not only can be made to furnish amusement, but might develop into an important mode of marine attack and defence. A small vessel of this kind carrying dynamite and running amuck among an enemy's fleet would be a very disturbing element in maneuvering. In these times, when new and important applications which once would have been pronounced "absurd" are a matter of almost daily record, we must be careful not to use the word too freely. The construction of Mr. Williams's model is very simple.

"A paper-board tube forming the body of the craft conceals the motive power, which consists of short rubber bands capable of stretching 1 ft. This motion of the rubber bands is multiplied to 6 ft., and the force is correspondingly reduced by means of a miniature rope tackle consisting of a silk cord passing to and fro six times through the tube around small box-wood pulleys and thence out of the rear end of the tube, where it winds around a drum ⅜-in. in diameter. The ends of the drum shaft are bent to form two cranks 180° apart and 2″ radius. Two slightly spoon-shaped paddles, made of sheet aluminum, are carried by the cranks, the upper ends of the paddles being constrained by two bamboo connecting rods. Fastened underneath the paper tube are two planes, 15″×2⅜″, which are placed equidistant from the center of gravity and inclined upward and forward at an angle of 6°.

"When placed in the water, the model sinks to about the middle of the tube, and, on releasing the paddles, it moves rapidly forward, raising itself until planes are on the surface, where it skims along in a straight line a distance of 40 or 50 ft. Waves of length less than one-half or one-third the length of the model appear to have little effect on its working, and ripples are rather beneficial than otherwise. They assist by catching the air and carrying it under the planes, where it spreads out into thin bubbles, thus materially reducing the skin resistance. It is only when the waves become so large that the craft is unable to preserve its horizontal position that the speed is noticeably effected.

"This principal resistance encountered by the hydroplane is the skin resistance, the wave-making and eddy resistance being reduced to almost nothing. When we recall that the resistance of ships at from twenty to twenty-five miles per hour is due one-half to skin resistance and one-half to wave-making, we can form some idea of the saving that may possibly be effected by largely doing away with the latter." Without following Mr. Williams in detail through his general remarks upon the subject of wave-making by vessels, skin friction, etc., we will simply state his conclusions (based on the experiment) that a high speed can be attained in such a craft, with properly-designed engines and machinery, and that a "hydroplane with energy enough to skim the surface of the water has more than enough energy to attain that condition from a position of rest where it floats in the water."

Waste and Supply of Shipping.

SOME interesting statistics compiled from "Lloyd's Registry" are given in *Engineering* (Oct. 11), relating to the continuous wearing out of shipping in service. The current supply not only must meet this waste, but must also provide for the general growth of marine commerce. During the single quarter of a year ending Sept. 30, two hundred and eight vessels of a total carrying capacity of 143,594 tons have been either lost or broken up, while on the other hand one hundred and fifty-nine vessels, having a total capacity of 290,330 tons, have been launched for merchant service. Decrease in number of launches and a very marked increase of tonnage are thus made apparent as a tendency of the period.

This tendency is regarded as fully accounting for the slow recovery of freights. Moreover, there is no present indication of any abatement of activity in ship-building. The ratio of the number of sailing vessels to that of steam vessels is small.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*2493. The Cunard Liners "Sylvania" and "Corinthia" (Full illustrated description, with two full page inset of engravings containing deck plans, vertical, longitudinal and cross sections, and other details). Engng-Nov. 1 2000 w.

*2495. Tubulous Boilers in the French Navy. John K. Robison (From the Jour. of the Amer. Soc. of Naval Eng. A general discussion of this class of marine boilers which shows that some of their advantages are yet off-set by grave defects. The three principal types discussed are the "Belleville," the "D'Allest," and the "Niclausse";

but something is also said of the Thornycroft, Normand and Lagrafel boilers. The first three named are regarded as the only ones having any chance of superseding the Scotch boilers). Engng-Nov. 1. Serial. 1st part. 3000 w.

*2525. Messrs. Bow, McLachlan and Company's Thistle Works, Paisley (Illustrated description of one of the most important English marine engineering establishments). Eng, Lond-Nov. 1. 3600 w.

2558. Twin Screw Steamships "North West" and "North Land" (Description of engines with illustrations showing details). Am Mach-Nov. 14. 500 w.

2579. Performance of the Steamer "City of Lowell." James E. Denton (An account of tests of performance. Condensed from a paper read at the N. Y. meeting of the Soc. of Naval Arch. & Marine Engineers). Eng News-Nov. 14. 1500 w.

2619. The Ventilation of the Boiler Room. From *Army & Navy Journal* (Proposes a change from the existing system based on the principle that each man must be his own refrigerator. Comparatively dry air is directed upon the nearly nude bodies of the men in order that perspiration may be rapidly vaporized and cooling produced). Am Eng & R R Jour-Nov. 14. 1400 w.

*2628. Steam Launch "Dragon Fly," for English Canal Inspection (A minute, detailed, illustrated description of a steamboat specially designed for inspection of narrow canals in England). Eng, Lond-Nov. 8. 1600 w.

*2632. The Belleville Boiler and Its Evaporative Efficiency (Evaporation results as taken from records of performance on the Russian Volunter steamship Kherson. Mean evaporation per lb. of coal burned was 8 88 lbs. Welsh coal of only average quality was used). Eng, Lond-Nov. 8. 900 w.

*2671. The Hydroplane. Ill. Harvey D. Williams (Describes an experiment demonstrating the possibility of a craft that will propel itself on the surface of water after the manner of a skipping stone). Sib Jour of Engng-Nov. 1200 w.

*2741. The History of Steamships. A. E. Seaton (A very interesting lecture delivered at a technical school). Prac Eng-Nov. 15. 1800 w.

*2742. The United States Cruiser "Minneapolis" (Full detailed illustrated description. Two-page inset of engravings). Engng-Nov. 15. 2800 w.

*2745. The Growth of the Port of Harwich. William Birt (Paper read before the British Asso. at Ipswich. Historical account of a port that has become important only during the last thirty years, but from which now sail, daily, passenger steamers to the Hook of Holland and Rotterdam and Antwerp; freight steamers to Rotterdam four times a week; steamers to Esbjerg three times a week; and steamers for freight and passengers to Hamburg twice a week. It is also the headquarters of the Royal Harwich Yacht Club). Eng-Nov. 15. 4500 w.

*2793. The Torpedo-Boat Destroyers "Rocket," "Shark," and "Surly" (Illlustrated detailed description). Engng-Nov. 22. 1600 w.

*2798. Marine Engineering Research (An argument in favor of such researches by scientific societies, and an account of researches upon Howden's system of forced draught. The assertion is made that the whole question of marine engineering, testing and trial has assumed, during the last few months, a national importance of the most pressing nature). Engng-Nov. 22. 1600 w.

*2799 Water-Tube Boilers. Hiram S. Maxim (The way circulation takes place in U-shaped tubes with heat applied at the bend). Engng-Nov. 22. 900 w.

*2800. Water-Tube Boilers. William Doxford & Sons, Limited (Practical experiences with the "Yarrow" boiler). Engng-Nov. 22. 500 w.

*2801. Water-Tube Boilers. A. F. Yarrow (A reply to criticisms made by M. Normand). Engng-Nov. 22. 500 w.

2817. Our Mercantile Marine (Editorial review and criticism of the U. S. Commissioner's report of navigation). Sea-Nov. 28. 1300 w.

*2819. The Application of the Law of Similarity to Marine Propellors. J. Denholm Young (Abstract of paper read before the North-East Coast Institution of Engineers and Shipbuilders. An exhaustive review of principles and practice in the construction of screw propellers, in which the topics treated are 1. Indicated horse-power and thrust. 2. Slip. 3. Wake. 4. Immersion of propellors. 5. Frictional resistance of screws. 6. Edge or head resistance of screws. 7. Centrifugal action. 8. Maximum thrust. 9. Different forms of screws. 10. Shape of blades. 11. Number of blades. 12. The turbine propeller. 13. Hydraulic propulsion. 14. Paddles. 15. Methods of procedure. 16. General considerations. An appendix is supplied, which contains a reduction of Mr. Froud's Constants under the law of comparison). Ind & Ir-Nov. 22. 4000 w.

2956. Our Navy (Summary of report of U. S. Sec. of the Navy, reprinted from New York *Journal of Commerce*). Sea-Dec. 5. 1100 w.

*2960. Shipbuilding on the Thames (Proposes to describe in a general way, the notable shipyards on the Thames, beginning in the first part with the yards of Messrs. Yarrow and Co). Ir & St Tr Jour-Nov. 23. Serial. 1st part. 1800 w.

2979. The Water-Tube Boilers of the steamer Zenith City. Ill. (This steamer is equipped with water-tube boilers, and is claimed to be carrying a ton of freight at a higher rate of speed, and with less consumption of coal than any other steamer on the lakes. Description). Eng-Dec. 7. 1300 w.

*2991. Development of the Marine Boiler. J. M. Dewar (Takes the ground that the present form of marine boiler is doomed to extinction and that the water-tube boiler is the coming type). Prac Eng-Nov. 29. Serial. 1st part. 3500 w.

*2996. Admiralty Contracts (A severe criticism of the business methods of the British admiralty exemplified by some recent transactions). Engng-Nov. 29. 1700 w.

MECHANICAL ENGINEERING

Exhaust-Nozzles and Smoke-Stacks for Locomotives.

A PAPER on the most advantageous dimensions for locomotive exhaust pipes and smoke stacks was recently read before the German Society of Mechanical Engineers, by Herr Troske, a translation of which is printed in the *American Engineer and Railroad Journal.* The following abstract of this paper is a historical sketch of the origin of the exhaust-nozzle, comprising also the principles that should govern its construction and design.

Soon after the construction of the first railway, experiments were instituted for the purpose of heating the exhaust-nozzle in the most efficient position ; and it is well known that Stephenson owes his victory in the locomotive contest at Rainhill, in 1829, to the fact that he was the first to make an application of the exhaust-nozzles to boilers for inducing a greater draft. Pambour, in 1836, was the first to institute a systematic series of experiments. He made, however, only a few, and the results that he obtained are of no great value. Nevertheless, Pambour set forth the proposition that the exhaust-pipe pressure varies directly as the speed of the piston and the generation of steam per hour, and, therefore, inversely to the sectional area of the pipe itself. He considered that the pressure in the exhaust-pipe was the same as the back pressure upon the pistons, until, in 1847, it was proven by Gouin and Le Chatelier that this is not the case. Among the French engineers who busied themselves with this question at the time was Polonceau. He made some special experiments with exhaust-nozzles of various sizes.

Clark first threw light on these subtle relationships by means of his very important and thorough investigations, made in 1850 upon a large number of locomotives. From them the following results were obtained :

1. The vacuum in the smoke-box stands in direct relationship to the pressure in the exhaust-pipe. That is, the vacuum expressed in inches of a water column gives the pressure in the exhaust-pipe in inches of mercury :

$$\frac{\text{Vacuum in smoke-pipe}}{\text{pressure in exhaust-pipe}} = \frac{1}{13.6}$$

or, say, $\frac{1}{14}$.

2. The draft-creating properties of the exhaust are dependent, first of all, upon the form and size of the stack and the position of the nozzle. Above all does the height of the exhaust-opening and the diameter of the stack influence in this matter.

3. With each stack there is some maximum size of exhaust-nozzle that will produce the best results. For a given boiler there is only one diameter of stack that is most efficient; for all other diameters the nozzle must be contracted.

4. The best position for the exhaust-nozzle is that from which the steam will be blown vertically into the stack. Hence the center line of the nozzle must coincide exactly with that of the stack.

5. The products of combustion must be able to enter the stack easily, either by making the bottom bell-shaped, or, better still, by locating the exhaust-opening at a distance below the top of the smoke-box about equal to the diameter of the stack.

The exhaust will thus be always blown through and through the products of combustion, and not merely over the top of the same. A straight vertical exhaust-pipe is, therefore, greatly to be preferred to the crooked pipe formerly in general use, since it offers less resistance to the steam as well as to the gases in their passage to the stack.

6. The proper sectional area of the exhaust-nozzle is dependent upon the great area, the sectional area of the tubes, the diameter of the stack, and the size of the smoke-box.

The larger the grate area and the sectional area of the tubes in the fire-box tube-sheet, and the smaller the diameter of the stack and the size of the smokebox, the larger it is possible to make the nozzle.

7. In order that a stack may work at its maximum efficiency, it must have a length that is, approximately, four times its diameter.

8. The smallest sectional area of stack which was observed was one-fifteenth of the grate area, and this permitted the use of a larger exhaust-nozzle than any other larger stack. So that these observations are taken to indicate that this proportion (one-fifteenth) is the most efficient.

9. The exhaust-nozzle may have a sectional area equal to from one-sixth to one-ninetieth of the great area, provided that the sectional area of the tubes in the fire-box tube-sheet shall be made from one-fifth to one-tenth of the grate area.

10. The vacuum in the fire-box is from one-third to one-half of that in the smokebox.

It should be remarked just here that the English locomotives of those days had very small grates, whose area did not average more than twelve sq. ft.; hence, rules 9 and 10 cannot be applied to locomotives of the present day. Furthermore, rule 3, and the second paragraph of rule 6, in which it is stated that the exhaust-nozzle can be enlarged as the diameter of the stack is made smaller, cannot be applied in their general construction to locomotives. According to the Hanover experiments, the vacuum can be increased by making the diameter of the stack less. With this, if the original vacuum is to be retained, the nozzle may be enlarged, which will result in the lowering of the pressure in the exhaust-pipe and the back-pressure upon the piston; but this enlargement of the nozzle must take place between narrow limits; else, the combustion will be poor and the coal-consumption increased. For this reason, then, it will be inexpedient to use the small size of stack that would permit the largest nozzle to be used.

Herr Troske asserts the belief that as large a smoke-stack as is possible is always desirable, and he emphasizes the importance of rules 2 and 5, above given. He also criticises Zeuner's rules of later date. The paper is of interest and value to designers of locomotives and others who desire to know the "true inwardness" of this vital part of a locomotive.

Steam-Boiler Efficiency.

PROFESSOR A. HUETT, of the Royal Polytechnic School, Delft, Holland, is credited by M. Westerbaan Muserling (*Engineering*, Nov. 1), with having introduced what is known as the "*chain rule*," for controlling the chief data in the designing of any steam boiler. The rule is written as follows:

$$\begin{array}{lcl} \text{lb C.} & a & 1 \text{ G. S.} \\ \text{G. S.} & 1 & b.\ \text{H. S.} \\ \text{H. S.} & 1 & c.\ \text{lb. W.} \\ \text{lb. W.} & d & 1 \text{ lb. C.} \\ \hline \end{array}$$

$$a.\ d. = b.\ c.$$

In this rule a stands for pounds of coal (lb. C.) burnt per hour, per sq. ft. of fire-grate surface (G. S.); b represents the ratio of boiler-heating surface (H. S.) to fire-grate surface; c symbolizes pounds of water evaporated per hour (lb. W.), per sq. ft. of boiler-heating surface; and d stands for pounds of water evaporated per pound of coal. The necessary connection between these quantities is shown for any boiler by setting the numerical values of the symbols in the middle columns in the above exemplified form. The continued product of the terms in the first of the inner numerical columns should be theoretically equal to the continued product of the terms of the second numerical column; and from the resulting equation the value of either a, b, c, or d may be obtained in terms of the other quantities, or numerically when the numerical values of the other quantities are substituted for them in the equation.

Mr, Muserling shows, by the application of the rule to experimental results obtained by Mr. Bryan Donkin from twenty-one different boilers, that the rule is a most efficient check on experimental results, as well as an aid in designing. The examples of this application to Mr. Donkin's experiments are so instructive and interesting that we present them herewith. The agreement is surprisingly close, except in one case—No. XVI,—in which there is a wide discrepancy. The small inaccuracies in the others are well within the limits of experimental errors. Thus the validity of the rule for the generality of cases is experimentally proved.

I.—*Vertical Boiler.*

lb. C.	17.9	1	G.S.
G.S.	1	73.4	H.S.
H.S.	1	2.33	lb. W.
lb. W.	9.57	1	lb. C.

171.30 = 171.02

II.—*Lancashire Boiler. Galloway Tubes.*

lb. C.	10.20	1	G.S.
G.S.	1	38.8	H.S.
H.S.	1	2.62	lb. W.
lb. W.	9.92	1	lb. C.

101.18 = 101.66

III.—*Lancashire Boiler. Galloway Tubes.*

lb. C.	18.5	1	G.S.
G.S.	1	38.8	H.S.
H.S.	1	4.78	lb. W.
lb. W.	10.02	1	lb. C.

185.37 = 185.46

IV.—*Locomotive Boiler. Wet Firebox.*

lb. C.	7.93	1	G.S.
G.S.	1	21.7	H.S.
H.S.	1	3.47	lb. W.
lb. W.	9.55	1	lb. C.

75.73 = 75.30

V.—*Locomotive Boiler. Wet Firebox.*

lb. C.	6.25	1	G.S.
G.S.	1	30.8	H.S.
H.S.	1	1.72	lb. W.
lb. W.	8.45	1	lb. C.

52.81 = 52.98

VI.—*Water-Tube Boiler. Syst. de Nayer.*

lb. C.	14.3	1	G.S.
G.S.	1	31.5	H.S.
H.S.	1	4.49	lb. W.
lb. W.	11.35	1	lb. C.

162.31 = 141.44

VII.—*Water-Tube Boiler. Syst. de Nayer.*

lb. C.	14.7	1	G.S.
G.S.	1	31.5	H.S.
H.S.	1	4.26	lb. W.
lb. W.	11.08	1	lb. C.

162.88 = 134.19

VIII.—*Cornwall Boiler. Galloway Tubes.*

lb. C.	6.86	1	G.S.
G.S.	1	33.3	H.S.
H.S.	1	2.34	lb. W.
lb. W.	11.4	1	lb. C.

78.20 = 77.92

IX.—*Lancashire Boiler. Galloway Tubes.*

lb. C.	16.0	1	G.S.
G.S.	1	44.6	H.S.
H.S.	1	3.87	lb. W.
lb. W.	12.4	1	lb. C.

198.40 = 172.60

X.—*Lancashire Boiler. Galloway Tubes.*

lb. C.	16.8	1	G.S.
G.S.	1	44.6	H.S.
H.S.	1	4.20	lb. W.
lb. W.	12.46	1	lb. C.

209.33 = 187.32

XI,—*Locomotive Boiler. Stationary Type.*

lb. C.	12.4	1	G.S.
G.S.	1	32.6	H.S.
H.S.	1	4.05	lb. W.
lb. W.	10.78	1	lb. C.

133.67 = 132.03

XII.—*Elephant Boiler. Three Bouilleurs.*

lb. C.	11.04	1	G.S.
G.S.	1	23.5	H.S.
H.S.	1	4.89	lb. W.
lb. W.	11.7	1	lb. C.

129.17 = 114.92

XIII.—*Locomotive Boiler. Goods Tank Engine.*

lb. C.	35.5	1	G.S.
G.S.	1	69.2	H.S.
H.S.	1	2.05	lb. W.
lb. W.	12.18	1	lb. C.

432.39 = 432.50

XIV.—*Locomotive Boiler. Goods Tank Engine.*

lb. C.	28.1	1	G.S.
G.S.	1	69.2	H.S.
H.S.	1	5.1	lb. W.
lb. W.	12.51	1	lb. C.

351.53 = 352.92

XV.—*Locomotive Boiler. Goods Tank Engine.*

lb. C.	31.7	1	G.S.
G.S.	1	69.2	H.S.
H.S.	1	5.62	lb. W.
lb. W.	12.29	1	lb. C.

389.59 = 388.90

XVI.—*Fire Engine Boiler. Horizontal Tubes.*

lb. C.	34.3	1	G.S.
G.S.	1	45	H.S.
H.S.	1	13.1	lb. W.
lb. W.	7.95	1	lb. C.

272.69 = 589.50

XVII.—*Cornish Boiler. Multitubular Type.*

lb. C.	13.7	1	G.S.
G.S.	1	54	H.S.
H.S.	1	2.52	lb. W.
lb. W.	9.91	1	lb. C.

135.77 = 136.08

XVIII.—*Locomotive Boiler. Portable Engine.*

lb. C.	10.8	1	G.S.
G.S.	1	27.2	H.S.
H.S.	1	3.85	lb. W.
lb. W.	9.57	1	lb. C.

103.36 = 104.72

XIX.—*Cornish Boiler. Galloway Tubes.*

lb. C.	15.7	1	G.S.
G.S.	1	19.3	H.S.
H.S.	1	7.43	lb. W.
lb. W.	9.16	1	lb. C.

143.81 = 143.40

XX.—*Cornish Boiler. Multitubular Type.*

lb. C.	21.5	1	G.S.
G.S.	1	40.2	H.S.
H.S.	1	5.42	lb. W.
lb. W.	10.15	1	lb. C.

218.23 = 217.88

XXI.—*Locomotive Boiler. Stationary Type.*

lb. C.	25.5	1	G.S.
G.S.	1	37.4	H.S.
H.S.	1	7.23	lb. W.
lb. W.	10.64	1	lb. C.

271.32 = 270.40

Mechanical Flight.

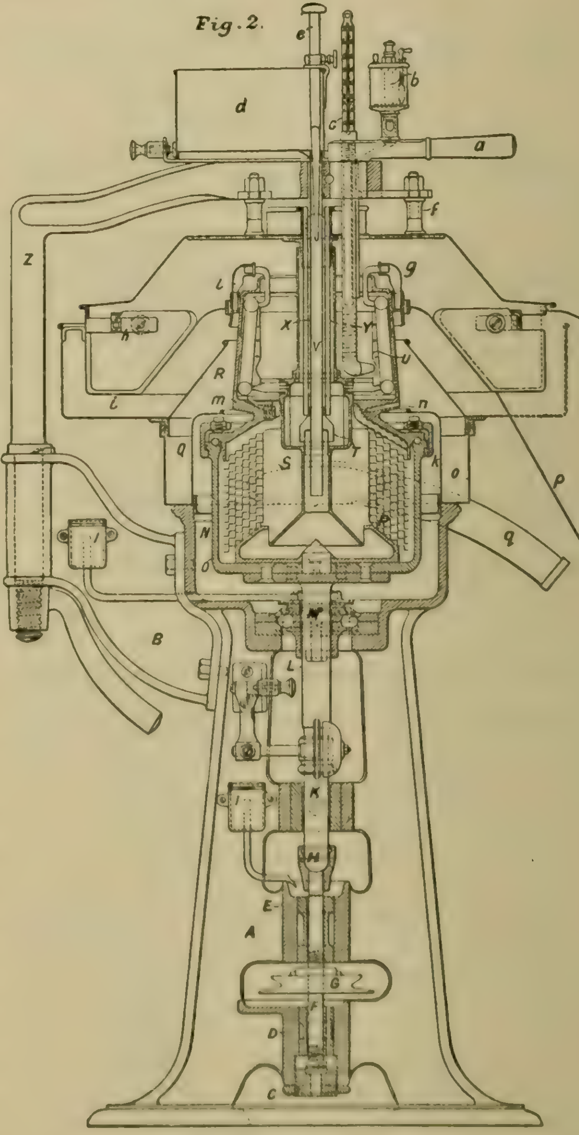
A SUFFICIENTLY exhaustive review of progress in this field of mechanical engineering (not too technical for the majority of readers interested in the subject) is printed in No. 8 of *Papers Read before the Engineering Society of the School of Practical Science*, Toronto. The paper is written from the standpoint that mechanical flight is soon to be an accomplished fact with which engineers will have to deal, as they now deal with locomotive and marine engineering; and, though this may be an over-sanguine estimate, the progress that has actually been made, as shown by the author of the paper, Mr. C. H. Mitchell, is really greater than is popularly supposed. Past failures are attributed mostly to the crude attempts of mechanics without scientific knowledge to guide their efforts; but, now that the scientific principles underlying flight are gradually being unfolded, the subject takes on a very different aspect. An attempt to give here an idea of all the information collected from a great variety of sources and presented in this paper would be vain; those interested in this line of study and invention should consult the article itself. The paper is confined to aviation as distinguished from aerostation, and it is predicted that all future progress will be in the direction of aviation—defined as being the navigation of the air by machines heavier than air.

Worm Gearing.

THIS much-criticised mechanical device is beginning to find defenders. It is now claimed by many good mechanical engineers that its defects have hitherto been due to want of skill in design and in application, and that such defects are not inherent. *The Mechanical World*, referring to experiments of Towne, Sellers, Reckenzaun, and others, says these experiments have shown that the device is capable of much more service than has hitherto been credited to it. Professor Stodola has also been experimenting with it. The worm used by him was 3⅛ in. in diameter, and "it engaged with a worm wheel having 28 teeth, the wheel being of bronze, 14¾ in. in diameter. The whole of this gear was placed in oil in a cast-iron box. The gear was coupled to a 20-h. p. electric motor, and the braking tests were made on the worm-wheel shaft. At 1,500 revolutions, a useful performance of 21 h. p. was given on the brake, the efficiency amounting to 87 per cent." It is believed that the efficiency may be increased to 83 per cent., if the following rules are regarded: "The starting speed should, according to the output, amount to from 20 to 40 ft. per second, instead of from 7 to 16 ft., as has hitherto been customary. This condition necessitates the use, not only of high motor speeds, but also of a large diameter of worm, and consequently great distances between the teeth, powerful teeth, and ample bearing surface. By this means the total friction will be reduced. For driving elevators the motors required range from 2 to 25 h. p., with usual speeds varying between 1,600 and 800 revolutions a minute. As the elevator drums to be operated, the driving spindles of machine tools, and the car axles of tramcars, have speeds of from 150 to 40 revolutions a minute, it is possible to obtain in the most simple manner, without any intermediate gear, the whole speed reduction by means of worm gearing, with a single- or double-thread worm having a ratio of reduction of 10 to 1 or 20 to 1." The construction of this kind of gearing for direct coupling requires great care. The worm should be of tool steel, accurately fitted, tempered, and polished, and the wheel should be of bronze. The friction while running in oil may thus be reduced very greatly.

A New Swedish Butter-Making Machine.

THE fame of the Swedish "separator," for separating cream from milk almost immediately after milking, is world-wide. In this machine, which is an admirable example of fine mechanical construction, advantage is taken of the small difference between the specific gravity of cream and skimmed milk, the separation being effected by centrifugal force in a rapidly-whirling mass of the liquid. Simple as is the principle, the mechanical difficulties in practically carrying it out, in such manner as to render it generally available in dairy countries, have been greater than could be imagined by any one not acquainted with them. In this machine, and in all devices of mechanical engineering for the treatment of milk and dairy products, Sweden has taken the lead, and a Swedish inventor now again comes to the fore with a machine for not only separating the cream from the milk in a brief time, as does the machine previously mentioned, but for converting the cream immediately into butter, without further handling. This machine is so ingenious in construction, and affords so good a mechanical study, that a vertical section illustrating its parts and their arrangement, and an abstract of a description from an article in *Engineering* (Oct. 4), are herewith presented.



SWEDISH BUTTER MAKER.

The machine is mounted on a frame much like an ordinary separator, the vertical spindle *L* being supported in a footstep and by side, anti-friction bearings, *K* and *M*; near the bottom of the shaft is the pulley, *G*, by which a rapid motion is imparted to the shaft. On the top of the latter is the cream skimmer, *N*, and above it is the churn, *R*. This latter is connected to the former by an easily-detachable joint, and there is free communication between the two. The whole milk is delivered down the central tube, *B*, and falls down into the skimmer through the cone, *S*, which lies within a concentric cone, *O*, that serves to distribute the milk in the separator. The separating and churning chambers are driven with a velocity of about 6000 revolutions per minute, which causes the cream to rise up the sides of the radiator in the usual way. A part of the cream, urged upwards, passes through the churning tube, *V*, part of which is perforated with a series of very fine holes, through which the cream is driven by centrifugal force with great velocity against the cream rising in the churn; the effect of this contact is to convert the cream almost instantaneously into butter, which passes through the opening in the top of the churn, and is removed by an automatic scraper. The skimmed milk flows off in the usual manner through the spout, *q*. A complete system of water circulation cools the cream and maintains it at the most effective temperature. The buttermilk issuing with the butter is collected and passed again through the churn.

In the complete installation of the system, the milk, collected from a group of dairies within a convenient radius, is delivered into a tank, and lifted by a pump into a pasteurizing tank, where it is heated to a temperature sufficient to sterilize it. The milk is then allowed to flow at a suitable rate into the radiator bowl, and forced into the churn, where it is immediately cooled by ice-cold water circulated from the tank, *i*, by a rotary pump, *G*, through the circulating tubes of the churn. The skimmed milk rises from the separator, and flows through a pipe into a cooler, outside of and separate from the machine.

This apparatus, invented by Mr. Gustaf Salenius, and called a combined cream separator and radiator churn, is in use in a number of European dairies, and it has been warmly approved by the department of agriculture in France; the size chiefly in use can deal with upwards of 180 gallons of milk per hour. In Sweden some of the dairies where it is employed are worked on the coöperative system. Each farmer brings his greater or smaller quota of milk, the butter-making value of which is tested in advance, and receives a credit note for the amount of butter that the milk contains. The deliveries are afterwards all mixed, and each farmer receives his proper proportion of skimmed milk, the account for butter being settled periodically. The same system of collection and coöperation prevails in the dairy regions of the United States.

It is claimed that butter made in this manner is of the finest quality, and that it keeps much better than butter made by previous methods.

Probably the reasons for this fact are that the rapidity with which the butter is made does not allow time for incipient chemical changes; and that the separation of the buttermilk from the butter is more complete than with butter churned in mass and having the buttermilk worked out by hand.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Technical Journals—See Introductory.

The Machine Shop.

2548. Compressed Air in Railway Shops. Ill. (Will present in this and subsequent parts, answers to the following questions sent out in a circular letter, by the Railway Age, to one hundred of the principal railway shops in the United States. 1. To what extent do you make use of compressed air in your car and locomotive shops? Please name tools and appliances and number of each in use. 2. What apparatus do you use for compressed air (special compressors, locomotive air pumps, or home made devices? 3. If locomotive air pumps are used, how many are required for your purposes and of what size are they? 4. What pressure of air per square inch do you use? 5. What pressure of steam is used to operate the air pumps? 6. How much steam of this pressure is required to compress one cubic foot of free air to the pressure named in answer to question 4? 7. Do you consider the locomotive air pump an economical means for compressing air for shop purposes? Please give reasons for your opinion. 8. In what line do you find the greatest economy to be developed from the use of compressed air for shop purposes)? Ry Age -Nov. 8. Serial. 1st part. 4800 w.

2559. The Test of Roller Bearings. T. W. R. McCabe, and George B. Woodruff (Details of tests made by the authors with shafting, both with and without roller bearings (Am Mach–Nov. 14. 900 w.

2560. Tests of Leather Belting. Charles H. Benjamin (These tests relate to the strength and elasticity of belting, without reference to strength of lacings). Am Mach–Nov. 14. 900 w.

2672. Some Uses of Cross-section Paper in the Machine Shop. William O. Webber (Containing practical suggestions relative to the use of cross-section paper, in keeping the run of shop expenses and estimating cost of jobs). Am Mach–Nov. 21. 1100 w.

2774. Setting a Milling Cutter—Boring and Inside Threading Tools—Making Soft Metal Molds. A. H. Cleaves (A suggestive and instructive practical article). Am Mech–Nov. 28. 2300 w.

2775. Neglected Possibilities of the Modern Machine Shop (Editorial suggestions on planning, arranging and equipping). Am Mach–Nov. 28. 700 w.

*2797. The Position of Draughtsmen (Editorial review of an address upon the subject of training engineers, delivered by Mr. Archibald Denny at the Institution of Junior Engineers). Engng–Nov. 22. 3000 w.

2836. Locomotive Cylinders. Herbert M. Ramp (Full directions, illustrated by engravings, for performing a difficult class of foundry work). Foundry–Nov. 2000 w.

2949. Data Relating to Forge-Shop Design. Paul M. Chamberlain (Illustrated description of forge shop in the mechanical department of Michigan Agricultural College with special reference to air-blast and suction for smoke expulsion). Ir Tr Rev–Dec. 5. 700 w.

*2989. Defects in Iron Castings. D. Brown (The variety of causes inherent in materials and workmanship, and the remedies). Prac Eng–Nov. 29. 2200 w.

*2990. The Construction of Worm Gearing. Ill. Herbert Aughtie (Calls attention to some points not too obvious to ordinary mechanics). Prac Eng–Nov. 29. 1100 w.

Steam Engineering.

*2494. Steam Boiler Efficiency (Rules for designing steam boilers and checking experimental determinations of efficiency, enunciated by Prof. A. Houet, of the Royal Polytechnic School of Delft, Holland, and communicated by M. Westerbaan Muserling). Engng–Nov 1. 300 w.

*2521. Steam Engine Economy : Condensing Engines. Henry Davey (A paper read before the Inst. of Civ. Eng. Treats of a method—not in common use—for examining results of engine tests, and which is substantially a comparison of indicator diagrams, with ideal theoretical diagrams at the same point of cut off). Col Guard–Nov. 1. 4000 w.

2609. Clean Boilers. F. T. (Treats of the practical use of kerosene as a material for cleaning and keeping boilers clean). Lord's Mag–Nov. 2000 w.

*2610. Internal Friction in Steam Engines. Walter William Houfe (Read at the Inst. of Marine Engs., Stratford. Regards what is called "cutting" in steam cylinders as more properly described by term abrasion, and seeks causes and remedies for this action. First part treats of causes). Marine Eng–Nov. 1. Serial. 1st part. 1900 w.

2643. Steam Engine Economy : Condensing Engines (Interesting and very full discussion by members of the Inst. of Civ. Engs., drawn out by the reading of a paper by Henry Davey, indexed above). Col Guard–Nov. 8. 9000 w.

*2665. The Accuracy of Valve Gears. Digna Sequamur (A criticism of terms in which the action of steam engine valves is generally stated). Engng–Nov. 8. 1500 w.

*2670. The Method of Initial Condensation and Heat Wastes in Steam Engine Cylinders. R. H. Thurston (Abstract from a paper read at the 36th session of the Inst. of Nav. Arch. An account of a preliminary study of the facts of the case, illustrated by the action of several different classes of engines with equations and diagrams). Sib Jour of Engng–Nov. 5800 w.

2673. Crank Shafts of Single-Acting Engines. W. H. Booth (An argument sustaining Wöhler's law of stresses and asserting this law is ignored in the design of crank-shafts). Am Mach–Nov. 21. 900 w.

2724. Economy in Compound Engines (The "Rockwood" system of proportioning cylinders. Principles underlying the system explained. A description of the system and a statement of advantages claimed for it). Bos Jour of Com–Nov. 23. 1200 w.

*2808. Internal Engine Friction (Editorial review of Walter W. Houfe's paper, elsewhere indexed. The paper is criticised as advancing a plausible theory, but as not covering the whole ground). Eng, Lond–Nov. 22. 1800 w.

2841. Test of the Detroit Pumping Engine (Report of George H. Barrus, with diagrams of steam engine performance, and tables of data and results). Eng Rec–Nov. 30. 6400 w.

†2876. Some Preventable Wastes of Heat in the Generation and Use of Steam. William Kent (A lecture delivered before the Franklin Institute. The subject is well covered but the lecture contains little that is new). Jour of Fr Inst–Dec. 4500 w.

2940. The Reliability of "Throttling Calorimeters." James E. Denton (Shows that the use of small throttling calorimeters, in testing the quality of steam, is unreliable unless used in conjunction with a separator to eliminate water from the steam and uniting determinations of drip from the separator, with those of the calorimeter). Eng News–Dec. 5. 1100 w.

*2987. Trial of a Pair of Beam Engines, Working Compound, Cylinders Steam Jacketed (Description of boilers and of the engine tests, and conditions under which the latter were performed with tabulated results and numerous engine diagrams). Prac Eng–Nov. 29. 2800 w.

Miscellany.

2490. Crude Petroleum for Fuel. George H. Larkin (Report of tests made by the writer, under horizontal return flue tubular boilers at the works of the Pacific Rolling Mills, San Francisco, using the Union Oil Company's standard 23 degree gravity fuel oil from the Santa Paula (Cal.) oil fields, fed through the Larkin oil burner). Jour of Elec–Oct. 1200 w.

*2496. Carbonic Anhydride Refrigerating Machines. E. Hesketh (Paper read before the British Asso. at Ipswich. Illustrated detailed description of a new English compression machine for liquefying carbonic anhydride for refrigerating purposes). Engng–Nov. 1. 3800 w.

2557. Some Recollections of Machine Shops in the Early Forties. Washington Jones (These reminiscences will be interesting to all mechanical engineers, especially so to the older members of the profession who have lived to see the enormous progress made since the period named). Am Mach–Nov. 14. 1700 w.

2613. Methods of Heat Insulation (Discusses the subject generally and follows with a consideration of asbestos as an insulating material, and methods of using it for this purpose). Ir Tr Rev–Nov. 14. 2000 w.

2618. The Most Advantageous Dimensions for Locomotive Exhaust-Pipes and Smoke-Stacks. Inspector Troeke (The question is discussed from the practical consideration of most effective draught. The first number gives an account of Zeuner's experiments, with an engraving of the apparatus employed, and also a description of Nozo and Geoffroy apparatus for testing draught efficiency). Am Eng & R R Jour–Nov. 14. Serial. 1st part. 5000 w.

*2633. Gibbs' Harvest Saving and Tea Drying Machines. Ill. (Interesting detailed description of a very unique machine for drying hay and other analogous farm produce). Eng, Lond-Nov. 8. 1100 w.

*2660. Combined Sleeper Adzing and Boring Machine (Illustrated description of a machine specially designed for adzing and boring seatings in sleepers of irregular form and of such hard woods as are used on the South American railways). Engng–Nov. 8. 300 w.

2667. Brakes and Fenders for Electric Cars. Oberlin Smith (Maintains that the fender problem has not been attacked from the proper standpoint. Not only protection for the body, but for the arms and legs should be provided. Gives hints). Ir Age–Nov. 21. 800 w.

2676. The Equipment of the Broadway Power Station of the New York City Cable Railroad System. Stuart Thomson (General description only). Safety V–Nov. 2400 w.

†2700. Local Annealing of Hard Faced Armor Plates. Herman Lemp, Jr. (Paper read before the Amer. Inst. of Elec. Eng. with discussion. Illustrated description of the process and apparatus necessary. Experiments described, and methods formerly used explained). Trans of Amer Inst of Elec Eng–Oct. 5300 w.

*2739. Modern Gas Engines. Frederick Grover (The first part is introductory and historical). Prac Eng–Nov. 15. Serial. 1st part. 2400 w.

*2772. Machinery in South Africa (A correspondent's account of what he saw of machinery in various African mines. The Meldrum furnace and other improvements at the Robinson. Progress on the Westleigh Mines. New Machinery at the Ruby and Heriot). Mach, Eng–Nov. 15. 1600 w.

*2807. American Self-Propelled Carriages. Ill. (A statement of the conditions of the Chicago competition, and an account of the entries and results). Eng, Lond–Nov. 22. 4000 w.

2823. The Recovery of By-products from Producer Gas. A. Gillespie, in *Journal of the West of Scotland Iron and Steel Institute* (The author disclaims a knowledge of the chemical value of the by-products of producer gas, but claims that if their recovery does not reduce the heat value of the gas enough to endanger its efficiency, he can show how they can be secured,—and then proceeds to explain the method and appliances needed for the purpose). Am Mfr & Ir Wld–Nov. 29. 2000 w.

2837. Fuel Oil for Foundries (Describes and illustrates the application of a system for using oil-fuel, to core-ovens and brass furnaces). Foundry–Nov. 1000 w.

†2924. The Smoke Problem. Richard J. McCarty (One of the ablest expositions of the principles of smoke production, and of the converse smoke prevention, that has ever been printed. The author concludes that while a great mitigation of the smoke nuisance can be reached, its total suppression, in the present state of knowledge, is impracticable). St Ry Jour–Dec. 5800 w.

2926. Ball Bearings and Rubber Tires for Carriages. Ill. (From *La Nature*. Gives a sketch of the history of the introduction of these devices, dating ball-bearings back to 1857). Sci Am Sup–Dec. 7. 1000 w.

2928. The Motocycle Contest (Brief account but comprising all the essential facts of the race, and concluding with the opinion that it has greatly advanced the art in this country). Ir Age–Dec. 5. 1200 w.

2930. John Fritz, President of the American Society of Mechanical Engineers. Ill. (Biographical sketch of a representative American mechanical engineer). Am Mach–Dec. 5. 7000 w.

2931. English Smoke Consumers. W. A. Carlile (Takes the ground that English smoke consumers are for the most part more appropriately "money consumers." Causes of their inefficiency are given. Present state of the art). Am Mach–Dec. 5. 1500 w.

2932. Steel, Fire and Water (Contains valuable and practical hints on hardening and tempering). Am Mach–Dec. 5. 2400 w.

*2978. The Dessau Gas Tramcars. W. von Oechelhauser (An account of the present status of the Dessau installment and of the success reached in this method of propelling cars). Gas Wld–Nov. 30. 1200 w.

*2993. The Philadelphia Pneumatic Postal System (Descriptive. The most interesting feature of the construction is the method of reducing cast iron pipe to a uniform bore by means of extemporized boring machines, having flexible boring bars). Engng–Nov. 29. 1300 w.

MINING & METALLURGY

The Rand Conglomerates.

At the usual monthly meeting of the Geological Society of South Africa a paper was read by Mr. Kuntz on the gold-bearing formations of the Transvaal. *The Mining Journal* (Nov. 16) quotes: "Like all sediments, the schists of the so-called Cape formation are of water-worn origin, deposited during the Devonian period, near a sea coast, and were formed of the South African primary rocks and the underlying granite." After discussing the formation and folding of the schists, with the attendant effects, the author accounts for the presence of the gold in the banket as follows:

"The question touching the origin of the gold in the conglomerates is a very difficult one, and has already caused a good deal of discussion, not only among South African geologists, but among those of other countries. Their theories on this subject are very different, the three principal ones being as follows:

"1.—The gold was deposited by some chemical precipitation from sea water, simultaneously with the deposition of the conglomerates. By certain chemical actions, perhaps in consequence of the gold containing water meeting waters containing sulphates of iron or any organic substance, the gold may have been precipitated and deposited in crystalline forms in the sediments then settling down.

"2.—The gold was deposited simultaneously with the formation of the conglomerates, as is the case with alluvial gold, and then subsequently dissolved and crystallized by means of percolating solutions. When the gold was discovered to be in the form of very small and deformed cyrstals within the cement of the conglomerates, it was assumed that the gold was dissolved in place and redeposited, as was evidenced by rich chutes in quartz veins, the presence of gold in the footwall, rich smaller leaders accompanying the reefs, enrichment in smaller parts of the reefs, etc, Up to the present time no gold of primary origin has been found in the conglomerates.

"3.—The gold was not originally present in the conglomerates during the time of their deposition, but is of secondary origin. The crystalline nature of the minerals in the conglomerates, especially in the cement of them, is the most irrefutable argument for their secondary formation, whether they were originally present or not. Supposing that small hollow spaces between the pebbles remained when the conglomerates were formed, and which allowed the percolation of solutions, why, in such hollow spaces, should there not occur actions which are usual in other similar hollow spaces,—for instance, in the clefts in which veins had been formed? The minerals in veins are formed in most cases by percolating solutions. This is proved by parallel actions observed within historic times. Respecting the material forming the veins, the views of geologists are not yet in accord to day. There are, however, two theories better recognized than the others,—the theory of 'lateral secretion,' and the theory of 'ascension,' as we call them in German. According to the first, all fillings of the veins originate from the adjoining rocks, and, according to the second, the filling material comes from below. Microscopic and chemical examinations of the vein rocks, as well as of the adjoining rocks partly decomposed along the veins, have been carried out at Freiberg, in Saxony, and Przibrane, in Bohemia, by which it has been proven that most of the minerals in the veins are contained in the undecomposed parts of the adjoining rocks also, whilst the immediately-adjoining partly-decomposed parts of the rocks are deprived of them. Considering that the percolating solutions often rise from a considerable depth, and are also percolating through rocks situated, perhaps, miles below the surface, which contain other minerals, it is quite natural to infer that these solutions may carry with them also elements of other minerals not contained in the upper attainable rocks. Thus the process of filling the veins can be explained sufficiently by both these theories, or by 'lateral secretion' alone, taking it in a broader sense."

"The conglomerates in which the pebbles are lying immediately one on another are generally richer than those in which the pebbles are imbedded in a surrounding fine-grained cement." In other words, the richest filling of spaces was where these cavities were not filled by fine material at the time the conglomerates were deposited, implying that the gold bearing solutions came after the pebbles were laid down.

Erhardt Process for Tubular Bodies.

AMONG the United States consular reports to the department of State will be found that of United States Consul-General Frank Mason on the later metallurgical developments in Germany. *The Iron Trade Review* extracts the following information from the later of these reports: "In the work at Dusseldorf the mandrels are operated by hydraulic pressure. and are usually set in a horizontal position, though this is immaterial, the matrices being held in position in massive iron bed-frames, and carefully adjusted so that the mandrel, being steadied at the point of impact by fixed guides, shall pierce the exact center of the billet, and, by compressing the yielding metal outwardly into the space between the mandrel and the matrix, produce a hollow body the shell of which is everywhere of exact and uniform thickness.

"Both mandrel and matrix, or either of them, may be round, square, hexagonal, or of any other desired sectional shape, so that round, square, or otherwise formed tubes may be made with equal facility. Not only wrought iron and steel, but copper and other malleable metals, are worked with entire success by this process, the only requirement being that the blank billet, in the case of each different metal, shall be worked at such temperature as to secure its highest degree of malleability and ductility."

"Among the varied purposes to which the process has been applied at Dusseldorf, the two simplest and most susceptible of ready description are the manufacture of shrapnel shells for the German field artillery and steel flasks for containing liquid carbonic and other acids. Similar to the manufacture of shells, acid flasks four or five feet long by eight inches in caliber are made and shaped by a single movement of the press, without a seam or flaw, and of such quality that the thin shells sustain an expansive pressure of two hundred and fifty atmospheres. So superior, indeed, is the work turned out by this method that the German government has required the principal maker of guns and projectiles in that country to adopt the Erhardt process for the manufacture of such war material as is delivered for the use of its army and navy. The economy of the process is said to be fully fifty per cent."

The Mining Schools of Germany.

THE growing interest in mines and the revival of mining booms has affected everything in any way related, so that the technical press is taking up the discussion of mining schools, and the qualifications and duties of the professional mining engineer. with considerable interest. This is especially noticeable in English journals, as evidenced by the appearance of a report by the United States consul at Chemnitz on mining and trade schools, which was abstracted under the head of "The Mining Schools of Germany" in the *Journal of the Society of Arts* (Oct. 11), and copied from with avidity by several other journals. The fact is that English mining schools, like English methods in metallurgy, are behind the times, and the English are beginning to realize the fact. Great confusion reigns in American mining courses, and the whole world seems to look to Germany for an example of what a mining course should be. To quote from the article mentioned:

"Among the many mining schools of Europe few, if any, are superior to those of Clausthal, in the Hartz mountains, and Freiburg, in the mineral mountains of Saxony. Throughout Germany the question of education—especally practical, technical, and industrial education—takes precedence of all others."

The establishment at Clausthal seems to be the best example to use for illustration.

"It is surrounded by mineral mountains, into which shafts have been sunk, and at whose bases are situated, in active operation, a great many smelting furnaces, machine shops, and factories. The value of these to the student is incalculable, and much of the success of the school is undoubtedly due to its favorable situation. Its origin, which dates back to the end of the sixteenth century, was due to a desire to furnish regular and exact instruction in the mathematics and mechanics necessary to the successful mining of the many metals and minerals known to be in the surrounding hills. . . . For four centuries the Hartz mountains have been worked, and at the present day, in spite of tremendous difficulties, by means of scientific methods, these mines are made profitable. The State works the mines and supports the school. Within a circle of 3 miles are the most important lead, silver, and copper mines, and the smelting works of the Upper Hartz. Some of the mines are worked to a depth of 3000 ft., with veins 150 ft. wide. One great advantage the students have is in seeing all kinds of ores smelted. Ores from all countries come from Clausthal to enter the crucibles and come out refined. The school aims at giving such a scientific technical training as will fit the students to take charge of mines and smelting works of all kinds and sizes . . . ."

There is a preparatory course beginning the week following Easter Sunday and lasting 24 weeks, and an advanced course from October to the close of July. There is a mining library of 14,500 volumes, and an additional one, at the students' disposal, of 13,500 volumes; also five hundred models, numerous charts, drawings, etc.; a chemical library and a laboratory accommodating fifty students; five hundred excellent geological cabinet specimens; collections of minerals, ores, metallurgical products, fuels; instruments used in mine surveying; and all other necessary apparatus.

Students must be at least 17 years of age. The fees are very moderate, the usual fee being 3 marks for 1 hour per week; daily work in assaying and chemical analysis, 18 marks per month.

"Students may be examined in any subject taught in the school, and in everything in mining and metallurgy. If successful, they get diplomas and certificates of fitness, signed by the proper authorities. There are examination fees of 30 marks, when three students come up at once, and 6 marks for each additional student. For the degrees of mining and metallurgical engineer, 75 marks are charged, and 60 marks, if for one of these alone,—*i. e.*, mining engineer or metallurgical engineer. The studies themselves comprise (1) trigonometry, algebra, and geometry; (2) physics, practical physics, electricity, and mechanical theory of heat; (3) chemistry, theoretical chemistry, practical work in the chemical laboratory, chemical technology; (4) mineralogy, practical mineralogy, general geology, special and practical geology, and ore deposits; (5) elementary mechanics, higher mechanics, instruction in the construction of machines; (6) concentration of ores and mining; (7) surveying; (8) metallurgy and fuels—general metallurgy, special metallurgy, lectures on fuels and metallurgy of iron; (9) blowpipe analysis and assaying; (10) general jurisprudence—historical, Roman church, German and Prussian laws, private rights, State laws, German mining laws, general doctrines, ownership of mines, mining companies, miners' customs; (11) political economy—trade statistics and administration; (12) emergency lectures—physiology and anatomy of the human body, and how to aid the injured (means, natural and artificial, general aid, aid in special cases, and transportation of the wounded). During the latest year for which returns are available it appears that, of the total number of persons attending the Clausthal School, 110 were Germans, 18 English, 1 Dutch, 13 Americans, and 11 students whose nationality was not distinguished."

As a rule American schools pay too little attention to subjects (10), (11), and (12), though President Drown, at a recent alumni banquet of one of our leading engineering schools, stated that it would be the policy of his institution in future to broaden the field, especially in the direction of the "humanities" and political economics.

The Semet-Solvay Coke-Oven.

THESE ovens are in operation at Syracuse, N. Y., where they are found, according to the *Engineering and Mining Journal* (Nov. 30), far superior in various ways to the ordinary bee-hive oven. "There is no comparison between the two systems. At Syracuse, using a coal of 80 per cent. fixed carbon and ash, the Solvay ovens yield in regular work no less than 82 per cent. of good coke and 3 per cent. of 'breeze'; that is, the yield in coke exceeds the total fixed carbon plus ash, some of the volatile carbon evidently being condensed in the coking. The cost of the ovens is no greater than the bee-hive oven per ton of coke produced.

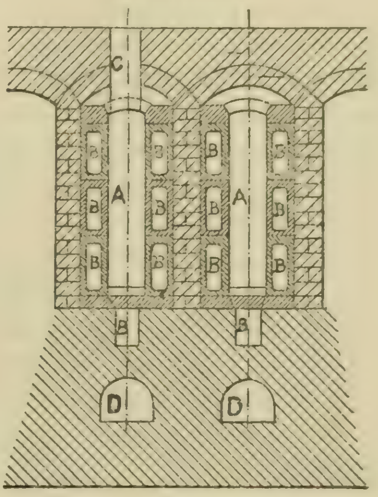
"The by-products are 45 lbs. of tar worth 18 cents per ton of Morris Run coal; 15 lbs. sulphate of ammonia; and 12,000 to 15,000 cu. ft. of 22-c. p. gas. The ovens are heated by producer gas, of which 160,000 cu. ft. is obtained per ton of coal. The by-products more than pay for the coal and the running of the producers.

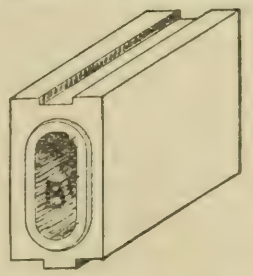
"With Connellsville coke the Solvay ovens produced 15 to 20 per cent. more coke than is obtained by the bee-hive ovens, and gave about 21 lbs. of sulphate of ammonia and 100 lbs. of tar per ton of coal.

"In general arrangement the ovens are grouped together, the combustion gases being led from the side flues of the ovens through the bottom flue into a main flue, and passing from thence, through the boilers, into the chimneys. The coke is pushed out of the ovens by means of two steam rams, which are removed from one oven to another by an endless chain running along the ovens, driven by a capstan placed in the engine-house. This arrangement permits the working of all the ovens with one single ram, in case of breakdowns. These steam rams receive their supply of steam from the boilers by means of a pipe line placed along the ovens, which is connected with the rams by movable elbow-joint pipes.

"The gases disengaged from the coal during the coking process pass first into a hydraulic main put up on each set of ovens. From there they are led through wrought-iron pipes to the condensers, whence they are drawn through the exhausters, and forced through washers, back to the ovens. The peculiar construction of the hydraulic main obliges the gases to bubble through a small depth of water, whereby the cooling of the gases is greatly accelerated, and the formation of hard tar is prevented. The condensers are double jacketed, with continuous water circulation.

Cross section





"The coal is charged through (C) into the coking chamber (A).

"The heating arrangement is shown in the drawing. Part of the gas is introduced in the upper range of hollow tiles (B), on the side of the steam ram (A), and, passing successively through the intermediate and lower ranges, the gas descends to the flue under the floor of the oven. Another part of the gas is introduced on the opposite side into the middle range. The object of this division of the gases is to avoid overheating certain points and to obtain a better distribution of heat. The air needed for the combustion of the gas is admitted close to the first gas inlet, and is previously heated to a temperature of 392° to 572° F., by the brickwork under the floors of the ovens, in the following way: beneath the flues, under the floors, are channels (D) through which the air, drawn by the chimneys, is made to pass before entering the upper range of hollow tiles where the first introduction of gas takes place.

"The dimensions inside the ovens are as follows: length, 30 ft.; breadth, 1 ft. 2 in. on the side of the steam ram and 1 ft. 3 in. on the other side; height, 5 ft. 8 in. The brick walls are two bricks thick, or 16 in., and the thin sides of the tiles or retorts 3 in. The ordinary ovens have to be altogether pulled down and reconstructed after about 10 years' working, whereas with the Semet-Solvay system it is sufficient to replace the independent side flues, which does not cost more than $100 per oven.

"Every ingress of air into the ovens has been carefully avoided. The doors are designed in such a way as to enable an easy and efficacious luting. All the other openings, such as the charging shafts and the cleaning holes in the ascending gas-pipes, are closed by covers with faced joints, maintained in place by springs, thus avoiding any further luting. The coke coming out of the oven does not show the slightest trace of combustion, and thus proves that the oven is thoroughly air-tight.'

The Cause of Increased Gold Production.

MANY people are apt to look to superficial causes for the explanation of the growth of the gold-mining industry, instead of reducing the question to a basis of stern business conditions. An editorial in *The Mining Industry and Review* (Nov. 21) ridicules the statement of a contemporary that the increased production was due to the invention of new processes, and says that "it is very largely due to the unavoidable operation of one of nature's mercantile laws. That law is: when there is more than ordinary profit obtained from the production of any article, the production of that article at once increases very rapidly. . . . . Because gold mining has increased in profit year by year, it has attracted constantly increased attention from prospectors, miners, and capitalists, and the inevitable result is an increased production. Why it has increased so rapidly year by year in profit is because the product of gold mining has year by year increased in value. The ounce of gold is worth $20.67,—which is its coinage value,—and it has been the same for over fifty years. But the cost of producing the ounce of gold declines as prices fall. How much that cost has declined in a few years can be seen from a comparison of the following tables of prices of the articles which constitute the expense account in mining at the present time and of twenty-five years ago:

	1870.	1895.
Stamp mill charges per cord..	$35.00	$16.00
Labor per day...............	4.00	2.50
Lumber per M feet..........	60.00	18.00
Teaming per day...........	16.00	4.00
Candles per box.............	20.00	4 75
Giant powder per lb........	1.00	.14
Fuse per M feet............	30.00	6.00
Nails per keg..............	20.00	3.00
Iron per lb......	.25	.03
Steel per lb....	.40	.09
Wood per cord..............	8.00	5.50
Coal oil per gallon..........	3.00	.20
Shovels each...............	2.75	1.00
Picks each.................	3.75	1.00
Rope per lb.	.60	.15
Smelting per ton..........	65.00	10.00

"On an average, $27 will buy as much mining supplies as $100 would buy in 1870. And yet the one ounce of gold is worth in coin just $20.67, which was its coin value in 1870. Does any one want any further reason why there has been such an increase in gold production than can be found in these figures?"

The cheapening of supplies he states to be due to "closing the mints to silver," thus throwing the labor and supply market into gold mining. A great part also is attributed to improved furnace practice and the economies derived from handling large quantities of ore. The prosperity of our gold-mining interests is local, and the "eastern farmer, southern planter, and debtor anywhere have little or no share. It is one which affects only the gold miner and the industry of gold mining, which to-day is the most prosperous and profitable business on earth."

Florida Pebble-Phosphate Mining.

THERE are two distinctive methods of mining land-pebble, which for convenience may be termed " dredging " and " hydraulic." The first naturally applies to such mines as raise the rock from under water, and the last to such as work in dry pits. It is scarcely necessary to add that dredging is sometimes a matter of necessity and not of choice. Some car-mining has also been done in pits that could be drained, but such work has been found unprofitable, and has been wholly abandoned. In dredge-mining, all types of machines have been used. We need not here discuss the relative merits of the " dipper," the " clam-shell," and the " elevator," as their adaptability is largely governed by location and environment. Whichever one is used, the function is simply that of raising the stuff from under water and passing it to the wash-boat alongside the dredge.

All washing is done by some attrition-process, the log-washer in some form being in almost universal use. The amount of manipulation required for clean washing varies considerably in different deposits, or even in different parts of the same deposit. The *débris* is carried directly overboard, unless the necessity for preserving navigable water forces a partial departure from this practice. The washed material is taken to the mill for drying and storing. Hydraulic mining presents some points of advantage which will probably always hold it in favor wherever it is practicable, that is, wherever the pit can be pumped dry with a reasonable amount of pump-capacity. The term fairly describes the process, which is simply to play giant-nozzle streams, supplied by strong hydraulic pumps, against the wall of the pit. This rapidly disintegrates the mass and carries the loose material to the sump-hole, where it is taken up by a centrifugal pump and carried to the washer.

The advantages are : (1) the washing is largely done in the pit, and only a small washer is needed on the barge or at the mill ; also, the amount of washing in the pit can be regulated to meet the work of the washer, thus making it easy to handle material of varying tractability always to the best advantage ; (2) the work being always in sight, the deposit can be worked clean without taking up worthless material ; (3) it is probably the cheapest method of raising the rock ; (4) it is less destructtive of soft pebble.

It may be remarked *en passant* that soft pebble indurates rapidly by exposure and heat, so that whatever gets through the washer is not lost in any subsequent screening. The best processes now in use for mining and preparing the rock leave little room for future economies, as the plants now in operation are free from many former errors of construction and adjustment of machinery.—Trans. Am. Inst, Mining Eng.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Technical Journals—See Introductory.

Metallurgy.

2497. Shall Pig Iron be Sold in Analysis? (An editorial discussion concluding that the only satisfactory way to sell pig iron is on its per cent. composition). Eng & Min Jour–Nov. 9. 1300 w.

*2523. A New Cementation Process (A new method with similar purpose to that of the Harvey system ; consists in cooling the steel before the carbon can penetrate into the molten mass too far while pouring. A section of the mold is given). Col Guard–Nov. 1. 600 w.

*2526. The Prospects of Steel Making in India. M. (Investigations into the relative cost of producing iron in India and Durham, England, and Connelsville, U. S., with the conclusion that there is a reasonable prospect for profit in pig iron made in India). Eng, Lond–Nov. 1. 2500 w.

2538. The Use of Blast Furnace Slag. Translated from *L'Industrie* (The use of acid slag by charging it, instead of ore, in blowing out a furnace. Also the advantage of using slag in place of a poor ore to increase the slag made to the required percentage. In actual practice both these methods were found to be economical). Am Mfr & Ir Wld–Nov. 8. 1200 w.

2554 —$1.50. The Physical Qualities of Acid Open-Hearth Nickel Steel, as Compared with Carbon Steel of Similar Tensile Strength. H. H. Campbell (Read before Am. Soc. of Civ. Eng. A valuable paper giving the results of tests on nickel steel, "hard forging" steel and forging steel in order to determine their comparative qualities when manufactured into various shapes. The superiority of nickel steel is clearly shown). Trans Am Soc of Civ Eng–Oct. 1000 w.

2590. The History of Mond's Nickel Extraction Process. Ludwig Mond (Abstract of a paper read before the New York Section of the Society of Chemical Industry, giving the results of experiments which led to the present process of absorbing the nickel by C O gas). Eng & Min Jour–Nov. 16. 1500 w.

*2598. Concentration of Gold Ores. T. K. Rose (Review of a book by Henry Rosales). Nature–Nov. 7. 1600 w.

*2625. On the Treatment of Zinc Ores and Complex Ores Containing Zinc. Peter Hart (From the *Journal of the Society of Chemical Industry*. The process for removing zinc from ores by treating with sulphuric acid and dissolving the soluble sulphates, and driving off the acid by heat leaving the oxide of zinc behind). Aust Min Stand–Oct. 19. 2000 w.

2637. The Manufacture of Tin Plates. Ill. (Some observations on the industry with description of an American mill which will be continued in the next issue, also with the description of an English tin plate mill). Met Work–Nov. 16. Serial. 1st part. 1600 w.

*2641. Pig Iron from Inferior or Dirty Ores. Walter J. May (Suggesting the use of a sodium-iron alloy in furnace practice to remove oxygen and injurious impurities from the iron). Col Guard–Nov. 8. 1100 w.

*2664. The Spectrum of the Bessemer Flame and the Hardening of Steel. John Parry (A correspondent's discussion of Prof. Hartley's paper on "Thermo-Chemistry of the Bessemer Process." He gives some results of his own researches on the effect of temperature on the spectrum of iron, says that iron is not a simple element, and discusses Mr. Howe's paper on "The Hardening of Steel"). Engng–Nov. 8. 1300 w.

2666. The Production of Iron Ores in the United States in 1894. John Birkinbine (From the mineral resources of the United States. The production of iron ores classified by years, by states, by most prominent mines, and by countries, is given in tabular form. It is an official report to the U. S. Geol. Survey). Ir Age–Nov. 21. 2800 w.

2668. A Contest in the German Iron Trade (On account of the exhaustion of cheap high phosphorus iron ore, the Rhenish-Westphalian district, which makes basic steel, desired a reduction of freight on government railways. This was opposed by a competing district and extensive investigations followed. It shows, as in this country, the tendency to move furnaces near the ore rather than near the coal supply). Ir Age–Nov. 21. 1100 w.

*2674. The Nature of Alloys (Abstract of the second and third of a series of lectures on alloys, showing how alloys will separate from the molten mixture at certain temperatures, having a different composition from the eutectic alloy. This separated alloy is not always the best for mechanical purposes. The mass should be cooled quickly in order that no segregation may take place). Ir & St Tr Jour–Nov. 2. 900 w.

*2681. The Iron Industry of the Saar and the Moselle. M. Jung (A paper communicated to the German Association of Engineers on the minette ores of Germany and their smelting, with economic considerations). Ir & Coal Tr Rev–Nov. 8. Serial. 1st part. 1600 w.

*2682. The Recovery of By-products in the Iron Industry (The utilization of the ammonia in furnace gases, the tar and ammonia from coke ovens, high phosphorus slags, &c., in Great Britain. In Scotland their value is said to be 3s. per ton of pig iron made). Ir & Coal Tr Rev–Nov. 8. 1200 w.

2705. Erhardt Process for Tubular Bodies (From the report of the U. S. Consul General at Frankfort. A method of forming tubes by forcing a mandrel into the hot metal contained in a matrix which is the shape desired in the finished piece. It is said to be an excellent process). Ir Tr Rev–Nov. 21. 1100 w.

2706. Contributions to the Chemistry of the Cyanide Process. E. A. Schneider (An article upon the economical use of potassium cyanide in the cyanide process and the causes for excessive consumption). Eng & Min Jour–Nov. 23. Serial. 1st part. 1300 w.

2707. Plant for the Separation and Disposal of Slag. Ill. L. S. Austin (This plant is in use at the Omaha & Grant Smelting & Refining works. Allowing sufficient time for the matte to settle from the slag is the principal feature). Eng & Min Jour–Nov. 23. 750 w.

†2712. Burnt Steel.—An Application of Theory. B. F. Spaulding (Showing the effect of oxidation and giving means for its prevention). Ind & East Eng–Oct. 19. 1600 w.

†2713. The Basic Bessemer Process (Extracts from a German circular on the importance of basic steel. Germany has contributed about half the world's production). Ind & East Eng–Oct. 19. 800 w.

2786. Analytical Methods at Duquesne. Ill. J. M. Camp (The determination of manganese by color test, of sulphur by the aqua regia or iodine method, and carbon by the method of combustion). Ir Age–Nov. 28. 1600 w.

2809. Stretching Cast Iron and Elements Involved in Its Contraction. Thomas D. West (Read at the meeting of the Western Foundrymen's Assn., at Chicago. A paper on the rel tions between contraction and conditions of molding, mixing and cooling the castings, with illustrative examples). Ir Tr Rev–Nov. 28. 4400 w.

2810. Properties of Cast Iron Shown by Keep's Cooling Curves. W. J. Keep (The effect of silicon on shrinkage and results of some recent tests). Ir Tr Rev–Nov. 28. 2300 w.

*2821. The Capabilities of Our Blast-Furnace Plant (Though the number of furnaces has decreased in England, the productive capacity has increased ; but this capacity is much greater than the actual production). Ir & Coal Tr Rev–Nov. 22. 1100 w.

*2825. Chrome Ore as a Furnace Lining (Stating that very good results were obtained by lining the furnace with two parts of powdered chrome ore to one of lime. The chrome ore should contain 36 to 40 % of chrome sesquioxide). Ir & St R Jour–Nov. 16. 400 w.

2827. The Rarer Metals and Their Alloys. W. Chandler-Roberts-Austen (A lecture before the members of the Royal Institution covering the entire field, including alloys with iron and steel). Can Min Rev–Nov. 9500 w.

2828. The Semet-Solway Coke Oven (An illustrated description). Eng & Min Jour–Nov. 30. 1000 w.

*2847. On the So-called "Selective Action." James Mactear (A paper read before a meeting of the Inst. of Mining and Metallurgy tending to prove that there is no "selective action," but rather that a greater proportion of base metal is dissolved by cyanide). Min Jour–Nov. 23. 4400 w.

†2865. Assay of Auriferous Ores and Gravels by Amalgamation and the Blow-Pipe. R. W. Leonard (The method consists in amalgamating with mercury, then cupelling with lead and measuring the bead with Plattner's scale. Results are compared with parallel tests with the stamp mill and fire assay). Trans Am Inst of Min Eng–Nov. 1200 w.

†2879. Carbides of Iron. F. Lynwood Garrison (History of the efforts to explain the phenomena connected with the affinity of carbon for iron). Jour Fr Inst–Dec. 2500 w.

2938. The Cyanide Process of Gold Extraction. John C. Montgomerie (A letter to the editor giving reasons why the MacArthur-Forrest patents are not valid). Min & Sci Pr–Nov. 30. 2000 w.

2945. The Relation between Temperature and the Grain of Steel. A. Sauveur and H. M. Howe (A diagram showing the relation of the area of the grain of steel of 1.10% carbon to the temperature from which it had cooled. The formula deduced is $T_{max}=680+281, 250\ a$ where T_{max} is in degrees centigrade and $a=$ area in sq millimeters of grain). Eng & Min Jour–Dec. 7. 400 w.

*2995. Brown's Horseshoe Roasting Furnace. Ill. (A hearth furnace of the O'Hara type, having continuous stirrers, which stir the roasting ore and convey it to leaching tanks. The plant is erected in Montana). Engng–Nov. 29. 1300 w.

Mining.

*2469. Cripple Creek Gold Mines and the Stock Boom. T. A. Rickard (Describing the geological formation of the Cripple Creek region and the character of the ore, and deploring the reckless speculation to which its richness has given rise). Eng Mag–Jan. 3500 w.

2498. The Oruro Silver Mines in Bolivia. Jorge Basadre (Description of the method of ore treatment. The mine ore is divided into the 130-oz. per ton grade, which is shipped to Europe, and the 60-oz. grade, which is treated at their mill by the chlorination process, at a cost of $14.31 per ton). Eng & Min Jour–Nov. 9. 1000 w.

2499. The Bowie Coal Mine, Texas. Ill. (The article says two Texas coal mines are now in operation, one working on a vein 22 to 26 in., and delivering about 300 tons per day, and the other where about 1800 tons a day are mined. Coal lies 401 ft. below the surface, contains 47% carbon, and costs from 70 to 80 cts. per ton to mine). Eng & Min Jour–Nov. 9. 1000 w.

*2500. Leadville, Colorado (Some details relative to the situation and organization of various mining enterprises showing the companies to be rather conservative and not anxious to invite outside capital). Min Jour–Nov. 2. 3000 w.

*2501. The Gold Mines of the Remedios District, Republic of Colombia. Frank Owen (A full account of the location, production, ore treatment, etc., of the various gold mines in this district. The mines were producing in 1613, and had produced 50 million pounds sterling of gold up to 1886). Min Jour–Nov. 2. Serial. 1st part. 3800 w.

*2502. Indian Manganese (Description of ore with analysis of manganese ore from Gosalpur, Jabalpur District, containing 54.66% of manganese). Chem Tr Jour–Nov. 2. 300 w.

*2519. South African Coal (The Transvaal coal occurs in the Karoo formation at depths from the surface to 100 ft. ; the largest has 40 ft. of workable coal, the others up to 22 ft. in thickness. The coal contains about 15% of ash, which also contains as much as 9 dwt. of gold per ton of coal. The production of the three principal mines has been 501,422 tons in 1894, employing 124 whites and 2005 natives. Its evaporative efficiency varies from 43 to 81% o. that of British coal). Col Guard–Nov. 1. 800w

*2520. Belgian Coal Industry in 1894. M. Emile Harzé (Abstract from the "Statistique de Mines, Minières Carrières, Mines Métallurgiques et Appareils à Vapeur, pour l'Annee 1894." The article gives the production as 20,534,501 tons from the 262 collieries, produced by 117,103 workers, receiving £4,406,792 in wages, making after proper deductions 2s 7d. per man per day. Also a vast amount of detail statistics given). Col Guard–Nov. 1. 2300 w.

*2522. Hard-Coal Species. Theodor Hundhausen, *Prometheus* (On the classification of coals, giving typical analyses and stating all the difficulties involved in subclassifying any variety). Col Guard–Nov. 1. 2300 w.

*2542. Dry Concentration of Gold Ores (Referring to the various methods adopted in dry treatment and describing its application to a North Wales mine). Aust Min Stand–Sept. 28. 1300 w.

*2623. The Greatest Gold Mine in the World. Edgar Hall (A history of the Mount Morgan (Aust.) Gold Mine with abstracts from descriptions by various government geologists, T. A. Rickard, and London *Engineering*). Aust Min Stand–Oct. 5. Serial. 1st part. 2700 w.

*2624. Dry Placer Machines (Description of the method of working dry placers in the arid regions of Arizona. Panning is used on a small scale similar to the wet method. The machine used consists of a series of screens arranged so that a blast of air from the fan blows sand and dirt away; it resembles the fanning machine used to clean grain). Aust Min Stand–Oct. 5. 1000 w.

*2626. Coal Mining in New Zealand (From the annual statement of the Minister of Mines giving the output of the mines, earnings of the miners, etc. The production was 719,546 tons, employing 1899 men at an average pay per week of £2. 3s. 9d). Aust Min Stand–Oct. 19. 1000 w.

*2627. The African Diamond Mines (An account of some of the early diamond discoveries in South Africa. A Boer, named Van Nickerk, produced the first large stone which he obtained from a witch doctor for £400 in "trade," sold it to Colony Jews for £11,200, and it is now reposing in the casket of a Countess, a 46½ caret gem, worth £25,000. Other similar instances are given). Aust Min Stand–Oct. 19. 2500 w.

2639. History of the Anaconda Mine. Marcus Daly (Personal reminiscences of one of the owners). Min Ind & Rev–Nov. 14. 1400 w.

*2640. The Coal Fields and Mine Administration of Germany. E. Gruner (From the general technical description accompanying the Atlas of the Comité des Houillères de France. A brief account of the German coal and lignite deposits with the official organization in mine administration). Col Guard–Nov. 8. 2200 w.

*2642. Composition of the Air in the Mines of the Doultz Basin. N. Kotsowsky (Translated from *La Revue Universelle des Mines, de la Metallurgie, &c.* Analyses from various parts of these Russians mines are given showing that the gas exists in dangerous quantities and that ventilation is defective). Col Guard–Nov. 8 3200 w.

*2659. Quarrying. C. Le Neve Foster (A lecture at the Sanitary Institute, London, by one of Her Majesty's Inspectors of Mines. An interesting summary of methods in use in England). Stone–Nov. Serial. 1st part. 2100 w.

2675. Roumanian Petroleum (Comparison of the analyses of oils from the nine principal oil fields of the world, showing the Roumanian oil to be very rich). Am Mfr & Ir Wld–Nov. 15. 250 w.

*2680. British Labor and the Iron and Coal Industries (Abstracts from the annual report of the British Board of Trade, giving tables of interest on trades unions, boards of arbitration, wages, &c). Ir & Coal Tr Rev–Nov. 8. 1000 w.

2690. The Granite Quarries of Stone Mountain, Georgia. Ill. (The mountain is a solid mass of granite rising to 700 feet above the level of the plain. Quarrying is done by blasting and breaking to size by the plug and feather method). Eng News–Nov. 21. 600 w.

2696. Notes on Gold Milling in California. E. B. Preston (From Bulletin No. 6, California State Mining Bureau. The author gives the development of present practice in detail. A valuable contribution). Min & Sci Pr–Nov. 16. Serial. 1st part. 1800 w.

2697. The South's Coal. H. S. Fleming (The growth of coal mining as illustrated at the Atlanta Exposition. The article contains descriptions of coal from various localities and gives the analyses, and production, and other statistics). Mfrs Rec–Nov. 22. 4500 w.

*2747. The Rand Conglomerates. Mr. Kuntz (A paper read at a meeting of the Geological Society of South Africa. It gives the various theories as to the origin of the formation and the contained gold deposits). Min Jour–Nov 16. 4000 w.

*2767. The Ruhr Coalfield. M. E Gruner (A report of the Comité Centrale des Houillères de France on the nature of the coals, importance of the deposits, political division of the field and the production). Col Guard–Nov. 15. 1800 w.

*2768. New Shaft Installation at the Preussen I. Pit, near Dortmund (Description of the improved machines used for the purpose of working with the utmost possible economy). Col Guard–Nov. 15. 1100 w.

*2795. Phosphate Dressing Plant (A dressing plant composed of screens, jigs, tables, etc., designed to enrich a poor phosphate rock 20 to 30 %. A full page plate shows the arrangement of the plant). Engng–Nov. 22. 1000 w.

*2824. The Lode Structure of the Zeehan Silver-Lead Fields, Tasmania. E. Moriarty Weston (A geological and mineralogical description of the rich argentiferous galena deposits on the west coast of Tasmania). Aust Min Stand–Oct. 26. Serial. 1st part. 2200 w.

2829. Some Georgia Marble Quarries. Ill. (This gray marble is quarried entirely by channeling machines, gadders, etc., and no explosive is used. The deposit is at least 200 ft. thick). Eng & Min Jour–Nov. 30. 900 w.

2843. The Monazite Deposits of North and South Carolina. Ill. H. B. C. Nitze (An interesting article by the Asst. State Geologist of N. Carolina, on this interesting thorium producing mineral. This is one of the localities from which the world draws its supply). Pro Age–Dec. 2. 1500 w.

*2844. Some Effects Produced by the Sudden Compression of the Ventilating Air Current in Mines. James Ashworth (Illustrated account of a mine accident caused by a creep of the strata, which suddenly filled the passages, expelling the air with sufficient force to kill some miners). Col Guard–Nov. 22. 5400 w.

*2846. Methods of Mine Timbering. Ill. (Extract from Bulletin No. 2 of the California State Mining Bureau. Examples of square setts are given, including those used on the " Comstock Lode"). Min Jour-Nov. 23. Serial. 1st part. 2800 w.

*2848. A Year's Mining in Western Australia (Some facts and figures from the Report of the Department of Mines of Western Australia giving the production, revenue, and area covered). Min Jour-Nov. 23. 1200 w.

†2854. The Present Condition of Gold-Mining in the Southern Appalachian States. H. B. C. Nitze and H. A. J. Wilkens (A monograph, well illustrated, and conveying the latest information regarding these interesting deposits). Trans Am Inst of Min Eng-Nov. 40000 w.

†2855. Notes on the Magnetization and Concentration of Iron-Ore. William B. Phillips (Results obtained, with detailed description). Trans Am Inst of Min Eng-Nov. 10500 w.

†2856. The Magnetic Separation of Iron-Ore. Clinton M. Ball (Derivation of formulæ for calculating richness of magnetites; description of the Ball-Norton Magnetic Separator, with some results of its working). Trans Am Inst of Min Eng-Nov. 6000 w.

†2857. The Gold-Regions of Georgia and Alabama. William M. Brewer (Descriptive paper taking up the localities in detail and showing the state of development). Trans Am Inst of Min Eng. Nov. 7200 w.

†2858. Southern Magnetites and Magnetic Separation. Harvey S. Chase (Some results of experiments—the Cranberry Mines, N. C. Also representative analyses of N. C. and Tenn. iron ores). Trans Am Inst of Min Eng-Nov. 2000 w.

†2861. The Tin-Deposits of Durango. C. W. Kempton (Communication in discussion of the paper of W. R. Ingalls, showing that the deposits are not sufficiently extensive for mining). Trans Am Inst of Min Eng-Nov. 150 w.

†2862. Notes on a Southern Coal Washing Plant. William B. Phillips (Discussion of the paper of J. J. Ormsbee. Showing the relation between specific gravity and composition of some Birmingham coal). Trans Am Inst of Min Eng-Nov. 1000 w.

†2863. Notes on Certain Water-Worn Vein Specimens. F. C. Holman (The occurrence of water worn pebbles, etc., in a quartz vein 265 ft. beneath the surface). Trans Am Inst of Min Eng-Nov. 2000 w.

†2864. The Florida Pebble-Phosphates. E. W. Codington (Description of method of mining and preparing for market). Trans Am Inst of Min Eng-Nov. 3300 w.

2937. Handling Refractory Placer Ground. Ill. (A gold dredging plant at Bannack, Mont. The bucket dredge uncovers the river bottom and then makes a dam further up stream; the water is pumped from the pit below and the rich gold gravel excavated to rock by hand). Min & Sci Pr-Nov. 30. 1400 w.

2944. Quarter of a Century of Fluctuations in Mining Stocks (A table giving the name of mine, state, par value, and highest and lowest prices of stock for each year since 1871). Eng & Min Jour-Dec. 7. 600 w.

2946. Millions in Gold Beneath the Lava Flows. Dan de Quille (A section of country in Idaho, 400 miles in length, by 40 to 60 miles in width, covered by lava, under which bore holes have discovered gold bearing strata). Eng & Min Jour-Dec. 7. 1800 w.

2947. The Gold Regions of Alabama. William M. Brewer (Showing that the gold deposits worked are not beyond the prospecting stage. The ore is quartzoze and comparatively free milling). Eng & Min Jour-Dec. 7. 1000 w.

2948. The Douglas Creek Placers, Albany County, Wyoming. E. P. Snow (Description with map and half-tone illustrations). Eng & Min Jour-Dec. 7. 2000 w.

2950. The Iron Resources of Minnesota. Horace B. Winchell (Read before the Northwestern Immigration Convention. Valuable statistics are given and the economic phase of the industry is fully discussed). Ir Tr Rev-Dec. 5. 3500 w.

*2982. Installation of a Guibal Ventilator at a French Colliery. E. Gosseries (Description of the ventilator and the conditions it has to satisfy. The reasons for choosing this type and the tabulated results of experiments are given). Col Guard-Nov. 29. 2000 w.

*2984. Development of the Manganese Ore Trade in the Caucasus (Showing that the miners are selling ore at a loss to themselves). Ir & Coal Tr Rev-Nov. 29. 800 w.

*2986. Colliery Explosions Produced by Coal-Dust. Donald M. D. Stuart (The author advances the theory of intermittent subsidiary explosions). Ir & Coal Tr Rev-Nov. 29. 1600 w.

*2997. The Zeehan and Dundas Silver Field Tasmania. W. F A. Thomas (A paper read before the Inst. of Min. & Met. The geology and methods of mining are fully described). Min Jour-Nov. 30. Serial. 1st part. 4500 w

Miscellany.

*2467. The Future of the American Iron Trade. James M. Swank (Reviewing the rise of American iron and steel industries, showing by statistics their growth, and pointing out the factors likely to contribute to their increase). Eng Mag-Jan. 5500 w.

†2518. Notes on Mining Engineering and Economic Resources of Illinois (A valuable series of experiments on the economic value of Illinois coals, as shown by calorimeter tests and analyses and comparing actual value with selling price of various coals). 10th An Rept of Ill Soc of Eng & Surv. 450 w.

†2561. The Latest Eruptives of the Lake Superior Region. N. H. Winchell (The correlation between intrusive traps and sandstones in the Animikie and Keweenawan formations). Am Geol-Nov. 2000 w.

†2562. The Upper Silurian in Northeastern Iowa. A. G. Wilson (After a brief reference to the published information, the author describes the various formations and shows that there

were alterations in sedimentation between limestone and chert and that the Pentamerus beds have a fauna similar to the limestone overlying the Coralline beds). Am Geol–Nov. 2700 w.

†2563. High Level Gravel and Loam Deposits of Kentucky Rivers. Arthur M. Miller (Accounting deposits on the sides of the anticlinal by the presence of a glacial dam). Am Geol–Nov. 1800 w.

†2564. Origin of the Iowa Lead and Zinc Deposits. A. G. Leonard (A review of the various ascension, lateral secretion and descension theories of Messrs. Whitney, Chamberlin, Winslow, Blake, Kemp and Jenner, and concluding that the ore deposited was contemporaneous with the enclosing limestone and came from above). Am Geol–Nov. 2700 w.

†2565. The Devonian Series in Southwestern Missouri. Oscar H. Hershey (The lithologic and stratigraphic relations which place the formation under discussion in the Devonian. The paleontologic relations are not yet established). Am Geol–Nov. 1900 w.

2570. The North Carolina Mineral Exhibit. H. S. Fleming (Data concerning this collection which gives not only an excellent idea of the exhibit, but also of the parts of the state in which the minerals are found). Mfrs Rec–Nov. 15. 3000 w.

*2655. The Onyx Marbles. George P. Merrill (Their origin, composition, and uses, both ancient and modern. An interesting article giving the distinctive qualities possessed by each variety of onyx). Stone–Nov. Serial. 1st part. 3500 w.

*2657. The Sandstone Industry in 1894 (Giving the composition of various sandstones, and the United States production by states). Stone–Nov. 800 w.

*2658. Essential Properties of Building Stones. H. Foster Bain (From Monthly Review Iowa Weather and Crop Service. A general article). Stone–Nov. Serial. 1st part. 2200 w.

2756. Gold Production and Its Cause (An editorial stating that the increased interest in gold mining and in gold production is due to the fall in prices of supplies. Twenty-seven dollars will buy as much now as one hundred dollars would in 1870, though the selling price of gold has remained constant). Min Ind & Rev–Nov. 21. 600 w.

*2763. The Shale Oil Industry (The article describes the oil shale, methods of extracting the oil and its accompanying products. It employs two and one-half million pounds capital). Eng, Lond–Nov. 15. 2400 w.

*2776. Development of the Manganese Ore Trade in the Caucasus (Great increase over 1893, but reduction in prices and causes. Transportation difficulties, &c). Bd of Tr Jour–Nov. 800 w.

2811. A South African on South African Mines (A letter from Johannesburg giving reasons why Americans should invest in "Kaffir" securities, and showing that the remarkable recent developments are based on a genuine basis). Bradstreet's–Nov. 30. 2000 w.

2818. An Electric Mining Plant (Short, illustrated description of an 80 h. p. electric mine locomotive, which can haul daily 1200 tons of coal a distance of 3500 feet ; a five foot capacity coal cutter, and a gearless electric mine drill. These are used in Pennsylvania, near Pittsburg). Min & Sci Pr–Nov. 23. 400 w.

2826. Canada and the Gold Boom (An editorial giving examples of booms and promoters with reference to the past "Kaffir" boom and the possible Colorado and British Columbia speculations). Can Min Rev–Nov. 4500 w.

†2831. Central Michigan and the Post-Glacial Submergence. E. H. Mudge (The author fails to find sufficient reason for existing theories). Am Jour of Sci–Dec. 1400 w.

†2834. Stratigraphy of the Kansas Coal Measures. Erasmus Haworth (The article gives the succession of rocks and the fossils contained in each). Am Jour of Sci–Dec. 6500 w.

†2859. The Eastern Coal Regions of Kentucky. Graham Macfarlane (Description with a number of geological sections). Trans Am Inst of Min Eng–Nov. 3500 w.

†2860. An Improved Form of Protractor for Mapping Mine-Surveys. W. S. Ayres (Illustrated description). Trans Am Inst of Min Eng–Nov. 600 w.

†2866. Biographical Notes of Eckley B. Coxe. R. W. Raymond (The life of an active, useful man, in mining profession. The list of his inventions, literary works, and of the societies to which he belonged is given in full). Trans Am Inst of Min Eng–Nov. 12800 w.

†2867. Biographical Notice of Franz Posepny. R. W. Raymond (A short history of this specialist in ore deposits). Trans Am Inst of Min Eng–Nov. 5300 w.

†2868. Chrome in the Southern Appalachian Region. William Glenn (A historical description of the finding of chrome ore in the United States, with notes on the lithologic character of its associations and its manner of occurrence). Trans Am Inst of Min Eng–Nov. 7000 w.

†2869. The Geological Structure of the Western Part of the Vermilion Range, Minnesota. Henry Lloyd Smyth, and J. Ralph Finlay (A valuable contribution on the origin and associations of the rocks in this iron ore locality). Trans Am Inst of Min Eng–Nov. 18000 w.

*2985. An Enquiry into the Present Methods of Estimating Sulphur in Iron and Steel. F. A. Matthewman (Thirty chemists having made analyses of the same sample and not agreeing, the author attempts to point out where the cause for the variation lies. The results vary from 0.016 to 0.076 per cent. for pig iron sample). Ir & Coal Tr Rev–Nov. 29. Serial. 1st part. 3000 w.

2999. An Economical Air Plant Now Being Installed at the North Star Mine. Ill. Edward A. Rix (Description of a very complete system for the transmission and use of compressed air). Jour of Elec–Nov. 1800 w.

Sewer Construction in Water-Bearing Soils.

UPON the difficulties arising from ground water in construction of sewers, hints derived from the experience of Mr. Andrew Gates, of Muscatine, Iowa (presented by him in a paper read before the Illinois Society of Engineers and printed in its tenth annual report), will be of service to the younger members of the profession. Mr. Gates applies the term "continuously saturated soil" to all earth lying below the ground water level. He also directs attention to the fact that all ground water has a current, and that this may be "quite rapid in veins, the velocity, of course, depending upon varying conditions. The result of this is that more trouble wiil be experienced from one side of the trench than from the other, and the side which will give most trouble will be the inflowing side.

"In any disposition of ground water, for the purpose of protecting our work while building, and afterwards, we should not lose sight of the purpose for which the sewer is to be used. With a combined system it may be an advantage to get this water into the sewer properly, while with a separate system too much care cannot be taken to exclude it. When large quantities of water are encountered, with a separate system, if the gradients will permit, it should be drained off, emptying on the surface or into a storm-water sewer. If this is impossible, under-drains may be allowed to discharge into manholes, and these openings closed after the sewer is completed. In a combined system the quantity of water may be so great as to require similar means of disposal; but smaller springs may be run direct into the sewer, if such construction is used as will effectively keep out sand and earth."

Under-drains should be at least six inches in diameter, that the flow may not be too often interrupted by deposition of mud in them, Sump holes and pumps should be employed to prevent silting up of under-drains whenever the grades are light. "Hollow invert blocks, such as are made by several clay works," are recommended for under-drains for brick sewers. "The same trouble is experienced with them as with pipe under-drains in regard to their silting up, but they have several advantages over the pipe in other respects. They do not require the foot of extra excavation which the pipe does, and this is more of an item than might at first be imagined; for, when at the bottom of a twenty-foot trench, with a copious supply of water coming in, the moving of a foot of earth is not only expensive, but dangerous. If there is not more water than a hand-pump will handle, and the sewer is large enough for the pump to be set inside, it is convenient to leave an opening between the invert blocks about once in a hundred feet, wide enough for the suction pipe of the pump, which is to be set in the bottom of the sewer, and the water pumped back into the sewer. After the pump has been moved ahead, three or four bricks will stop the opening. A sump hole is made by leaving out a short section of the sewer, excavating below the bottom, and letting the underdrainage discharge into this. The pump can be placed over this hole, thus keeping the pump always behind the work. As often as the drain becomes clogged, the pump should be moved ahead, and, after being started in the new hole, the section from which it was moved should be built in. This method works equally well for pipe or brick sewers, and I have found it to be the most satisfactory way of using an under-drain. The drain should have a covering of at least six inches of fine gravel between its top and the bottom of the sewer. In quicksand the trench must be closely sheeted, using lapped sheeting if necessary; and in the bottom a shield made of sheet iron, U-shaped, six or eight feet long, fifteen inches deep, and width depending upon the size of pipe, should be driven down just in front of the pipe and in advance of the excavation, which should go below grade and be filled up with gravel. I have found ten to twelve inches of gravel in the bottom of a soft muddy trench to give a comparatively firm bed for pipe."

In soft bottoms "concrete may be substituted for the gravel, or for pipe sewers the bottom may be planked. This should be done by driving stakes in the bottom of the trench and nailing one-inch boards on top of them. The stakes should be so driven as to bring their tops in a line parallel to the grade line of the sewer. For very large brick sewers it may be necessary to put in a pile foundation; but for the smaller brick sewers a concrete foundation, or timber cradle, will usually be sufficient. If a cradle is used, it should be made of two-inch plank, and should have an inner radius equal to the outer radius of the sewer. It should be fastened together by ribs on the outside. A timber cradle should be set to grade."

The greatest care should be given to the making of pipe joints in quicksands. Gaskets of oakum well soaked in cement are recommended. Keep running water away from a brick sewer as much as possible, while constructing it. Water coming in from the sides of the trench gives the most trouble. This water may be cared for by "the use of short pieces of gas pipe built into the wall, thus allowing the water to run into the sewer and *taking the pressure from behind the wall.* Two or three handfuls of dry cement around the pipe behind the wall will prevent any water following through outside of the pipe. If the seepage from the sides of the trench is not too great, a back filling made by mixing fine gravel and dry cement will often prove all that is required. The use of the pieces of gas-pipe—they should be two inches in diameter and about three inches longer than the thickness of the wall — are of great advantage, not only in the construction of brick sewers, but in building manholes and any masonry or concrete work which has a pressure of water behind it. After the cement has thoroughly set, if it is desirable to stop the water running in, it can be done by driving a wooden plug deep into the pipe and filling the end with cement. When there are a few joints in brick work through which the water comes, they may usually be stopped by caulking rags into the joints and then working in cement.

"The second method of overcoming the difficulty caused by water coming in from the sides of the trench is to start small channels at the under-drain and build them up as the brick work progresses. If the soil is such as to require no sheeting below the invert, this may be done by setting two rows of brick on end behind and with the flat side against the wall, leaving a space of two or three inches between them. By cutting little channels in the side of the trench leading to these, or by being careful to keep the back filling well tamped and lowest at these vertical channels, the water will nearly all run to them and thus down to the under-drain." Some remarks upon pumps and their use conclude this eminently practical essay.

Electric Purification of Sewage.

SOMETHING has been said in this department relative to the so-called "Hermite" process for purification of sewage, this process having recently begun to attract much attention on account of its apparent efficiency and its cheapness. In a recent lecture at the Case School of Applied Science, and also at a meeting of the Cleveland Council of Sociology, Professor John W. Langley (reported in *Electricity*, Nov. 20) makes it very clear that the honor of this invention is due to an electrical engineer, Wolf, and that it was first carried out at Brewsters, N. Y., on the Croton water shed which supplies New York city with its water. It was tried afterward in Havre, France, and has been called the "Hermite" process throughout Europe, thus by implication crediting the invention to an experimenter who followed Wolf, though it is not at present certain whether he had been informed of Wolf's successful experiments or not. Professor Langley says that, when the drainage from the town of Brewsters (flowing into an adjacent marsh, and thence into streams in he Croton basin) was found to be a source of contamination, "Wolf proposed to decompose sea water by electrolysis, and to turn the solution of chlorine thus obtained into the drainage from the village. The plan proved to be completely successful, as shown by a report issued by Dr. Cyrus Edson, health officer of New York, in 1892 and 1893. By an expenditure of a little over five-horse power to work a dynamo, the sewage was completely disinfected, and at an estimated cost of less than one per cent. of that of the older methods using chlorid of lime or carbolic acid.

"The next important trial of the new method was in the city of Havre, in France, where it is known as the 'Hermite' process from the name of the inventor, who, in Europe at least, is considered to be the originator of the idea. After an extended trial of the system, a commission appointed by the mayor of the city made a lengthy report, establishing the following points: first, the method is cleanly, practical, and easily carried out; second, when the disinfecting fluid is allowed to lie a sufficient time in contact with the sewage, the bacteria are completely destroyed; none of them survive; third, an amount of free chlorine—one-half a gram to the liter of sewage—accomplishes complete disinfection; fourth, the process as worked at Havre, with the price of coal and wages there prevailing, seems slightly more expensive than the older methods by chemical precipitation, but this might be remedied by further experience.

"The next important installation is in the city of Ipswich, in England, where it is now being applied to the entire sewage system of the town, and with complete technical success if we may judge from a report which appeared last summer in the London journal, *Lightning*.

"The process consists in pumping sea water, or an artificial brine made from salt, through tanks in which are placed electrodes supplied with current from dynamos. The chlorids of magnesium and sodium in the sea water are decomposed into alkali at one pole and free chlorine at the other. The latter dissolves in the water and becomes the disinfecting fluid, which is then turned into the sewers, or is delivered to tanks in which the sewage is temporarily arrested. The disinfecting fluid itself is colorless, and has only a moderate odor of chlorine, while the alkali formed in the decomposition of the salt greatly lessens the corrosive action of the chlorine on metal pipes.

"In order to give a scientific basis on which to make estimates of the cost, I have made in the electrical laboratory of the Case School of Applied Science numerous experiments, using an artificial sea water which practically represented the real article. Small decomposing tanks were made after the pattern of the large ones, and the electrical energy used was carefully measured. From these it appears that 6.37 lbs. of chlorine can be made every hour from one electrical horse power This quantity, using the Havre estimate, would purify over 14,000 gallons of sewage per day of 10 hours. A hundred horsepower would therefore disinfect 1,500,000 gallons in the same time. The cost of the process will be but little more than the cost of electricity, plus that of pumping the sea water and the small additional amount for wages. These can be approximately estimated at 25 cents for 1,400 gallons when carried out on a scale of 500 horse power. Taking the wholesale price of bleaching powder, its cost to do the same amount of disinfection would be at least twenty times as great. For inland cities the cost of salt would have to be added; but even then the expense would still be much below that of bleaching powder.

"This method is one especially adapted to hospitals and large public buildings. No special electric installation would be necessary for buildings already wired for light and power, since a moderate amount of current could be drawn from them. The salt water could be decomposed in moderate-sized tanks placed on each floor, and allowed to run into the drain system in small quantities, either automatically or by hand regulation. Thus this cleanly and practically inoffensive fluid would fill the traps of the various sinks and basins, and so disinfect all the material while it was yet within the building and before it reached the city sewers."

Prevention of Freezing in Pipes.

THE following is the substance of an article by Dr. Bueb of Dessau, recently published in *Fortischritte der Industrie*, a translation of which is found in the *American Manufacturer*:

Since gas began to be adopted generally for lighting purposes, it has been the aim of gas engineers to prevent the "freezing in" of gas pipes. Until recently it has been the general opinion that the water vapor always present in illuminating gas caused the "freezing in" by its separation in frostlike form; and all the previously known methods for preventing this are based upon the principle of removing the moisture out of the gas before its entrance into the conduit pipes. A method formerly employed for this purpose was that of exposure of the gas in so called "freezing out" cylinders to cold, whereby the water vapor was condensed and frozen, and dry gas was obtained. But, as in the freezing-out cylinder not only the steam contained in the gas, but also large quantities of the light-giving gases, were separated, the "frozen" gas showed such losses of lighting power that the practical employment of this method was hardly possible.

An extraordinarily simple and cheap method of drying gas by means of sulphuric acid of certain concentration was patented by the German Continental Gas Company two years ago, and proved quite satisfactory in the beginning. In the last hard winter, however, the chandeliers and conduits froze in again, although the gas entered the distributing pipes entirely free from water, and an investigation showed that the pipes were perfectly stopped up by frostlike formations, just as if undried gas had been used. The only difference was that these formations did not consist of frozen water, but of frozen, almost chemically pure, benzol.

This discovery shattered at once the former opinion that the freezing in of the pipes was caused by the water vapor contained in the gas, and the author very soon discovered a method by which not only the freezing of the vapor, but also that of the benzol, was made impossible. This method is that, in the gas works, a certain quantity of alcohol vapor is added to the gas before it is passed through the meter. If, by the action of the cold, separation of water and benzol occur, the alcohol vapor carried along also separates, and, dissolving in the separated condensations of water and benzol, forces down their freezing temperatures so much that they will not congeal even at our coldest temperatures in winter, but remain in liquid condition. They can, therefore, flow back into the main conduit, and thence into the next condensing pot. A stopping up of the gas conduit by separation of solid condensations is made impossible in this manner.

The action of the alcohol vapor added to the gas is here altogether different from that caused by injecting liquid alcohol into frozen-up pipes. Dr. Bueb's method furnishes means of preventing freezing in altogether, while, in the former use of alcohol in gas works, it was only intended to thaw up conduits that were frozen in already.

In the last hard winter it was shown by experiments that the action of the alcohol vapor added at the gas works remains effective at a distance of three miles,—that is, the alcohol vapor remains in the gas. The action of the alcohol vapor, however, is stopped as soon as the gas has passed a wet gas meter, as the liquid in the meter absorbs the vapor. In the case of large establishments a small apparatus for evaporating alcohol is sufficient.

Steam or a small gas flame is used. The alcohol flows from a tank in a fine stream into the heated evaporator, where it is instantly volatilized. The hot alcohol vapor is conducted through a little pipe into the gas main, where it is at once absorbed by the gas.

In order to obtain the desired effect, about five grains of ninety-five per cent. denaturated alcohol must be added to a cubic meter of the gas; at very low temperature, about ten to twenty degrees below zero, this amount must be increased by one or two grains. In most cases it is sufficient to commence with evaporating alcohol about half an hour before the street lamps are lit, while the addition of alcohol in the day time would appear to be necessary in exceptional cases only.

This method was employed on a large scale last winter in the gas works at Dessau, where it gave excellent results. Its advantages must not be looked for in the saving of alcohol; on the contrary, in most cases more alcohol is consumed than in the old method, which aimed only at the removal of obstructions produced by freezing in. The great advantages of the new method are found in the saving of wages, and, above all, in the entire removal of interruptions in the distribution of gas, which occur at the most inconvenient time,—that is, in the winter.

The method will commend itself to all who are familiar with the behavior of alcohol with water as being sound in principle and very easy to put into general practice.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Gas Supply.

*2488. Units in Gas Technics (Deals with points affecting the measurement of certain quantities which are of interest in gas affairs, and calculations relating thereto. First number treats of standards of illumination). Gas Wld–Nov. 2. Serial. 1st part. 2500 w.

2528. Acetylene. W. W. Goodwin (Lecture delivered at 23d Annual Meeting of Am. Gas Lgt. Asso. Illustrated by experiments; cuts of apparatus and descriptions are given. The method of generating carbide of calcium, apparatus for decomposing the carbide, and showing its illuminating power, and the cost of its commercial production are presented. Discussion). Am Gas Lgt Jour–Nov. 11. 5000 w.

2529. Notes on the Storage of Oil at Gas Works. Frederic Egner (Paper read at meeting of Am. Gas Lgt. Asso. Various methods of storing oil are described and the description is followed by a statement of the author's practical experience in oil storage in the Metropolitan gas works, New York city. Discussion). Am Gas Lgt Jour–Nov. 11. 2800 w.

*2611. A Study of the Preston Gas Works (Contains particulars of one of the best conducted gas works in England, made so by the skill with which its engineering has been designed and carried out). Jour Gas Lgt–Nov. 5. 2700 w.

*2612. The Commercial Value of Photometry. A. C. Humphreys (Discusses photometry as applied to measuring the illuminating power of gas as an article of commerce. First part deals with scientific principles involved). Jour Gas Lgt–Nov. 5. Serial. 1st part. 3300 w.

2699. How to Prevent the Freezing of Gas Pipes. Dr. Bueb (Describes a new method employed in Dessau, for preventing the stoppage of gas pipes by the freezing of either water or benzol). Am Mfr & Ir Wld–Nov. 22. 800 w.

*2703. Gas Exhausting and Condensing. C. C. Carpenter (Paper read before the Southern District Asso. of Gas Engineers and Managers, with discussion. A consideration of and dissertation upon what are ordinarily the first two stages in dealing with coal gas after it leaves the foul main of the retort-house). Gas Wld–Nov 16. 4000 w.

*2715. The Chemical Purification of Illuminating Gas. MM. Delseux and Renard (This paper took the prize of 750 francs offered by the Société Technique, France. The subjects of gas washing and gas purification, their necessity and purpose, with practical suggestions for their effective conduct are treated). Jour Gas Lgt-Nov. 12. 2800 w.

*2787. Cleansing Spent Oxide. A. E. Broadberry (Description of experiments performed at Tottenham, Eng., and diagram illustrating apparatus used. With discussion). Gas Wld–Nov. 23. 3000 w.

*2957. The New Holder at the Middlesbrough Gas Works (Illustrated detailed description of a new rope guided gas holder). Jour Gas Lgt–Nov. 26. 800 w.

Sewerage.

†2503. The Purification of Water and Sewage by Intermittent Downward Filtration. Arthur N. Talbot (The system compared with other methods of water and sewage purification has proved its value. Discussion). 10th An Rept of Ill Soc of Eng & Surv. 2200 w.

†2504. Sewer Construction in Water Bearing Soils. Andrew W. Gates (A practical essay on methods of procedure in cases where pressure of water in the soil gives trouble. Short discussion by members). 10th An Rept of Ill Soc of Eng & Surv. 2900 w.

†2505. The Construction of a Seven Foot Single Ring, Brick Sewer. C. M. Rickard (The cause for the construction of this unusual sewer was limited appropriation. The nature of the soil through which it was run and the method of executing the work are described). 10th An Rept of Ill Soc of Eng & Surv. 1400 w.

†2507. Effect of Size, Grade and Length of Sewers upon the Efficiency of Automatic Flush Tanks (A practical discussion of the subject, reviewing current practice with automatic flush-tanks, and seemingly proving that at distances of 2,000 ft. the flow in a sewer is very little if

at all accelerated by the use of automatic flush-tanks). 10th An Rept of Ill Soc of Eng & Surv. 900 w.

2653. The Application of Electricity in the Sewage Problem (Abstract of a paper by John W. Langley giving the results of his experiments and investigations). Elec–Nov. 20. 1000 w.

*2661. The Adams Sewage Lift. Ill. (Detailed description of plant having 20,000 gals. daily capacity at Great Grimsby, Eng.) Engng–Nov. 8. 1500 w.

2728. The Sewerage of Taunton, Mass. (Describes place and manner of final sewage disposal, the general character of the system, its alignment, capacity, and relation to the removal of storm water, and details of construction). Eng Rec–Nov. 23. 3400 w.

†2935. Submerged Pipe Line for the Pennsylvania Sanitary Sewerage Company at Reading, Penna. William H. Dechant (Illustrated description followed by discussion). Pro Eng's Club of Phila–July-Oct. 4000 w.

Streets and Pavements.

†2511. Brick Pavement Construction. A. D. Thompson (Defective foundation, or soft paving brick, or both, are considered as the chief causes of failure. This position confirmed by history of brick paving in Peoria, Ill.) 10th An Rept of Ill Soc of Eng & Surv. 8500 w.

*2912. Brick Paving from Start to Finish. M. Nicholson (The author does not advocate brick in preference to all other material but aims to describe the best practice in brick paving, as he has learned it from experience and observation). Pav & Mun Eng–Dec. 4200 w.

Water Supply.

†2506. Preservation of All Sources of Water Supply from Sewage Disposal. Robert T. Orr (An argument in support of the proposition, that all sources of potable water supply ought to be protected from sewage discharges, and maintaining that whatever mode of purification is adopted the effluent contains elements of danger when freely discharged into sources of water supply). 10th An Rept of Ill Soc of Eng & Surv. 2400 w.

†2508. The Rockford Water Works, Rockford, Ill. C. C. Stowell (Descriptive and statistical with discussion by members). 10th An Rept of Ill Soc of Eng & Surv. 4000 w.

†2509. Western Springs Water System. Ethan Philbrick (Description of a system of water works and sewerage for a small town, of unusual completeness, being as comprehensive in scope and detail as would usually be found provided for a town of ten times the population). 10th An Rept of Ill Soc of Eng & Surv. 1400 w.

†2510. Cost of Pumping Water from Well to Reservoir. R. G. Young (Of practical interest to engineers of works where wells are the source of supply. Discussion). 10th An Rept of Ill Soc of Eng & Surv. 3500 w.

2587. The Fulda, Minn., Water Works (Illustrated detailed description). Eng Rec–Nov. 16. 1500 w.

2704. Water Supply of Portland, Ore. (A detailed illustrated description). Fire & Water–Nov. 23. Serial. 1st part. 1600 w.

2727. The Scotland, Pa., Stand-Pipe and Tower. Ill. (Full detailed description). Eng Rec–Nov. 23. 1000 w.

*2744. Water Purification (Describes the leading features of the Archbutt-Deeley process, hitherto used only for trade purposes, but about to be applied to improving hard waters for town supply. The water is purified by chemicals, and the time required for purifying any given amount of water contained in a tank is said to be usually one hour). Engng–Nov. 15. 2000 w.

2839. The Rhinelander, Wis., Water Works (Detailed illustrated description). Eng Recov.–N 30. 400 w.

2939. Submerged Cast Iron Pipe Intake for the Water Works of Erie, Pa. Walter C. Brough (The method of laying the pipes under water is described in detail). Eng News–Dec. 5. 2400 w.

*2992. Leicester Water Works (Illustrated general description of a pumping engine recently installed at Leicester, Eng). Eng, Lond–Nov. 29. 900 w.

Miscellany.

2593. Incandescent Lighting by Gas and Electricity in combination. Ill. (The burner designed by Louis Denayrouze, Engineer, of Paris. The description is full and complete, being taken from the Austria-Hungarian Patent Gazette, together with the drawings of the lamp accompanying the text of the specification). Pro Age–Nov. 15. 1300 w.

2614. Col. Varigault on American Fire Departments (A French view of our fire department systems derived from a tour of inspection by the chief of the fire department of Paris and his aids). Fire & Water–Nov. 16. 1900 w.

2692. The Colwell Furnace for Light, Inflammable Refuse, New York City. Ill. (Detailed description of the apparatus and of the system employed in collecting, sorting, and treating the refuse material). Eng News–Nov. 21. 1400 w.

2693. Combinations Among Contractors (Editorial discussion of the foundation facts in connection with contractor's combinations and of the equities between the parties in the fixing of prices for contract work). Eng News–Nov. 21. 2500 w.

*2709. Halifax Sanitary Regulations (Rules and regulations for the guidance of architects, plumbers, householders, and others using the water supply, to secure the sanitary condition of buildings). Can Arch–Nov. 2400 w.

2835. A Contribution to the Literature of Differential Photometry. W. H. Birchmore (An able article containing a table showing the differential areas in the spectra of sunlight, ethine flame, gasoline air-gas flame, and the same whitened; and a diagram of illumination curves of sunlight, ethine flame, gasoline air-gas flame, and of the latter passed through "neutral tint" to whiten it). Am Gas Lgt Jour–Dec. 2. 1800 w.

RAILROADING

English and American Railroad Cars.

OUR cousins across the Atlantic are beginning to realize the possibility of improvements in their railway service, and are consequently looking into our present practice with interest. *The Railroad Car Journal* (Nov.) abstracts from a paper read by Jeremiah Head at a meeting of the Cleveland (Eng.) Institution of Engineers, as follows: "I have already expressed an opinion that the Americans are ahead of us in railway vehicles. In the United Kingdom the average length of a passenger's journey is 7.2 miles. In the United States it is 22 miles, or three-fourths times as much. In our country, dining- and sleeping-cars are needed on very few lines and very few trains. In America, they are rather the rule than the exception. On account of the great distances, traveling must largely be done by night as well as by day, and this could not be long endured, if the cars were not made thoroughly comfortable. This is not a question of luxurious fittings, good attendance, good commissariat, and sleeping arrangements only, for these could be added to any vehicle of sufficient capacity. It is still more a question of easy springs, efficient heating and lighting, and freedom from draughts. In ordinary English rolling-stock the weight rests upon the two ends of a laminated spring, a buckle, carried by the axle-box, grasping the centre. Let us suppose the carriage, excluding wheel and axles, to weigh 12 tons, and to be carried on 6 wheels, each supporting 40 cwt. If time were allowed, the carriage would be raised ½ in. when the wheel rolls over a ½-in. obstruction, causing a blow on the carriage equivalent to 7.8 ft.-lbs. Now, instead of making passenger cars as light as possible, as our railway companies do, the Americans purposely make them heavy, even building weights (as I am informed) into the framework. The usual weight of a Pullman palace car is 30 tons, or 24 tons excluding wheels and axles, and is carried on bogies of 6 wheels each. By reason of an arrangement of levers, when the wheels pass over a ½-in. obstruction, the car body is raised but $\frac{1}{12}$-in. with a blow equivalent of 0.92 ft. lbs.

"On an English railway a passenger in any carriage, whether third- or first-class, can easily count every rail joint passed over by the nearest rail below him. On the New York Central I found it impossible to do this, because there were no jolts to count,—a result due partly to the bogie system and partly to the better mode of jointing the rails." After showing the superiority of American cars in heating, lighting, and ventilation, the paper continues: "English railway companies may fairly claim to have succeeded in conveying passenger traffic with far less dead-weight than the Americans. The average dead weight carried per passenger in the two countries in well-filled trains is approximately as follows:

	First-class.		Third class.	
	England.	America (Pullman car).	England.	America (ordinary car).
No. of seats in carriage..	30	30	50	70
Tare of carriage, tons.....	15	36	15	27
Tare per passenger, cwts..	10	24	6	7 7

"In the first and second columns of figures, I have compared English first-class carriages with the palace-, chair-, and sleeping-cars usual in the United States; and, in the third and fourth columns, English third-class carriages with ordinary American passenger-cars. I have not included separate dining- or kitchen-cars in either case.

"In freight-cars the Americans carry less dead weight than we do per ton of freight. Let us take the traffic in coal as an instance:

	England.	America.
Maximum load.........	8 tons.	30 tons.
Tare of car............	4 "	9 "
Tare per ton of load....	10 cwts.	6 cwts.

"This remarkable advantage over us is due to the use of very long cars carried on two bogies."

Number and Classes of Railway Employees.

IN the report of the interstate commerce commission for the fiscal year ended June 30, 1894, will be found valuable statistics relating to our railway systems and their management. *The Railway Age* (Oct. 25) takes from this report some statistics relating to men connected with the railways. In 1891 there was a total of 784,285 persons employed, which increased in 1892 to 821,415. "The large increase of nearly 90,000 in the 2 years from 1891 to 1893 is to be ascribed largely to the influence of the World's Fair, for which preparations commenced long in advance. The panic, however, tended largely to offset the increase of railway activity resulting from the exposition, and, when the great show closed and the general business depression was unrelieved, the railways were forced to sharp retrenchment; and so it is not very surprising that in a single year there was a decrease of nearly 94,000 employees from the extreme figures of the year before." The following table for the 2 years up to June 30, 1894, shows this decrease in detail:

Class.	1894.		18 3.	
	Number.	Per 100 miles of line.	Number	Per 100 miles of line.
General officers	7,035	4	6,610	4
General office clerks	24,779	14	27.584	16
Station agents	28,199	16	28,019	17
Other station men	71,150	41	75,181	44
Enginemen	85,466	20	38,781	23
Firemen	36,327	21	40,359	24
Conductors	24,823	14	27,537	16
Other trainmen	63,417	36	72.959	43
Machinists	29,245	17	30,869	18
Carpenters	36,328	21	41,878	25
Other shopmen	84,359	48	93,709	55
Section foremen	29,660	17	29,699	18
Other trackmen	50,711	85	180,154	106
Switchmen, flagmen, and watchmen	43,219	25	46,048	27
Telegraph operators and dispatchers	22,145	13	22,619	13
Employees — account floating equipment	7,469	4	6,146	4
All other employees and laborers	85,276	48	105,166	62
Unclassified	......	......	284	.....
Total	779,608	444	873,602	515

It will be seen that "the general and other officers number but 7035 out of the grand army of nearly 780,000, or less than one officer to over 100 privates."

Improvements on Prussian Railways.

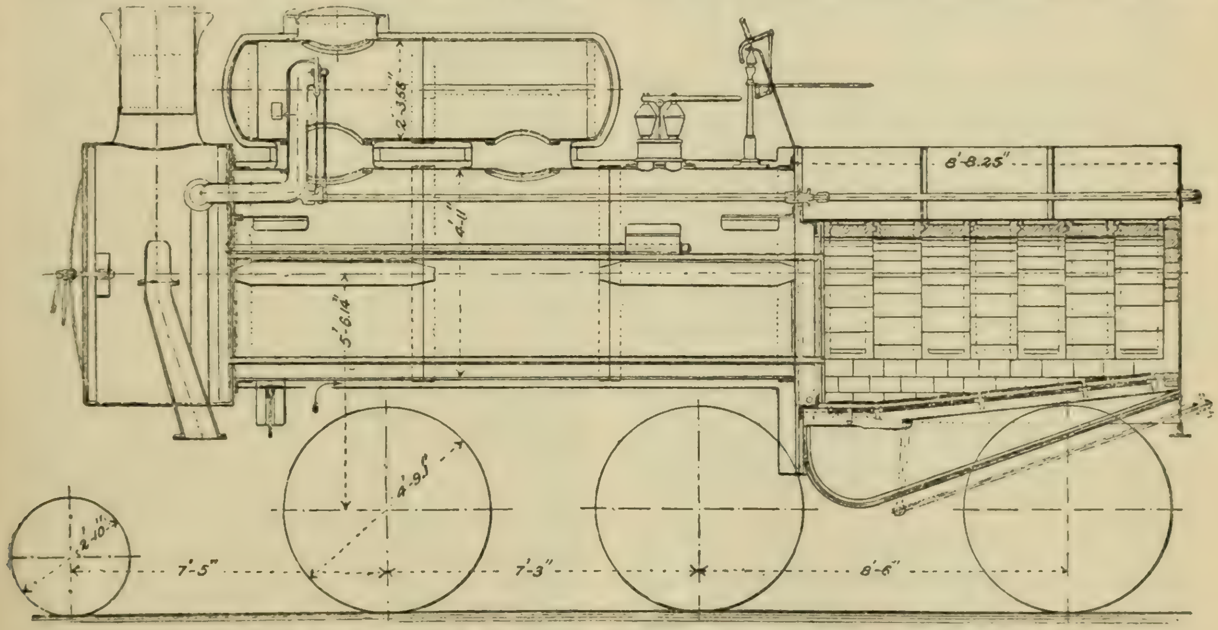
THE growing use in Europe of double-headed rail sections supported and keyed to cast-iron chairs is becoming so apparent that railroad men in this country should look into the reasons for this preference over flat-bottomed rails. In an excerpt from a paper before the Institute of Civil Engineers by Mr. R. Goering, the *Iron and Steel Trades Journal* (Oct. 19) thus remarks:

"Flat-bottomed rails on the Prussian State railways are gradually being superseded by double-headed rails with chairs. After discussing the advantages of chair permanent way over that with flat-bottomed rails, the author points out the directions in which the former requires improvement, which are as follows: (1) some means to prevent the sliding of the rails; (2) a better fastening between the rail and the chair; (3) an increase of the contact surfaces between the chair and the spike; (4) an increase of the bearing surface of the chair on the sleepers." The author submits designs covering the above proposed improvements, shown in two plates accompanying his paper. "The bearing surface of the chair on the sleeper he increases from 41 to 85 sq. in., and the weight from 17.63 lbs. to 50.7 lbs. The bearing surface of the rail has also been increased from 2.95 in. to 5.71 in., and three spike holes are provided, in place of two." The rails are fastened into the chairs by oak keys 8½ in. long by 2⅛ in. extreme width, costing 0.36 d. each. Treated wooden keys were found to possess no special advantage, and cost 2½ d. each. "The spikes are 7¼ in. long, with a diameter of 0.63 in., widening to 0.79 in. for the portion in contact with the chair. On the old permanent way eight sleepers are used for a rail 24.70 ft. long; on the new nine sleepers are used, the end sleepers being 0.94 ft. from their centres to the rail end, the intermediate sleepers being 2.82 ft. apart, center to center. The outside fish plates are 32.76 in. long and weigh 33 lbs. each, while the inner ones are

19.13 in. long and weigh 20 lbs. each." On the Brunswick and Meine line cast-steel keys were used in place of wooden ones with satisfactory results, though with a slightly increased cost. "The author estimates the cost per lineal yd. of this permanent way (excluding sleepers and ballast), with rails weighing 82½ lbs. per yd., at 18s. 3d.; and of permanent way, with flat-bottomed rails at the same weight, at 14s. 8d." Including sleepers and ballast, the cost would be, per mile, £2414 for the former and £2092 for the latter. Taking into consideration the greater cost of double-headed rail equipment, it would be interesting to know the reasons in detail for their increased use.

The Docteur-Brick-Lined Fire-Box.

IN a digest of an article in the *Revue Industrielle*, given in *The American Engineer* (Nov. 28), there is a description of a new feature in locomotive practice. "The Belgian railway has recently resumed the use of red copper tubes and coal; and tubes of this character seem to be giving satisfactory results. Also the red copper tube sheets in the smoke-boxes appear to act very well in service, but were entirely too expensive." The sides, top, and back of the fire-box are lined with firebrick, having an air space at their back. The reduction of heating surface is compensated by increasing the number of tubes.



LOCOMOTIVE ON THE BELGIAN STATE RAILWAY, WITH DOCTEUR'S BRICK LINED FIRE-BOX.

"The several tests which have been made with the new boiler have given very satisfactory results from the standpoint of the evaporation of water, which has risen to as much as 8½ to 9 lbs. of water per lb. of coal burned while hauling through trains with a light load.

"This locomotive has been in service since January, 1894. It was found that the combustion of the coal in the fire-box was perfect,—a result that is undoubtedly due, in the first place, to the high temperature which is maintained in the fire-box, whose walls are not continually cooled by contact with water, as is the case in the ordinary boiler; and, secondly, to the fact that the hot air admitted above the coal burning upon the grate is sufficient to burn all of the gases that are set free by the heat of this combustion.

"The admission of the air which circulates between the two casings in the arch of the double wall effects a perfect smoke consumption or smoke prevention, regardless of the quality of coal that is used; thus, the new fire-box has been stoked with the Flénu coal for welding furnaces, with pure semi-bituminous coals, with a mixture of semi-bituminous and hard coal, and, in all of these tests, it has been impossible to detect any difference in the color of the smoke. The steam capacity has been increased 25 cu. ft. by the drum shown.

"While the fuel consumption of the

same locomotive, with its old boiler, fired with good coal, was always more than 77 lbs. per mile, it has dropped, with this new boiler, to 54.2 lbs. on an average over a measured run of 11,625 miles.

"Two series of tests have been made with this boiler; the first related to the consumption of fuel and water. On averaging sixteen experimental runs, it was found that 7.7 lbs. of water were evaporated per lb. of coal burned.

"In the second series, the total work done by the locomotive was measured; the consumption of coal during the interval was taken into consideration, and finally an allowance of fuel was made to the engine for the work performed. The following are the results obtained:

DISTANCE RUN IN MILES.	Virtual Units Hauled	CONSUMPTION OF COAL IN LBS.			Allowance of Fuel Made in lbs.
		Bituminous.	Hard.	Total.	
210 65	25,984	3,528	6,615	10,143	17,223
908 46	119 888	18,960	36,162	55,122	73,749
531.28	68,776	6,615	21,160	27,775	39,038
1650.89	214,648	29,103	63,937	93,040	130,010

"It will be seen from these figures that the consumption of coal per mile run was about 56.38 lbs., or .43 lbs. per virtual unit hauled, which shows a saving in the total consumption of 36,970 lbs., or 33 per cent.

"Steam has always been generated in this boiler, even from cold water, in an hour and a half at the outside, whereas it ordinarily requires at least three hours. The expansion of the shell has been very accurately measured by means of marks on the frame, and it has never exceeded .16 in. to .2 in.

"These considerations have led M. Docteur to conclude that this boiler is absolutely safe, and that, furthermore, it will allow of a very important saving in the invested capital, as compared with the ordinary boiler on a freight locomotive which is of essentially the same dimensions,—this saving being placed at 5,000 francs" ($965).

Replacing Trestles with Earthwork.

IN describing some of the interesting features of the Canadian Pacific Railway before the Canadian Society of Civil Engineers, Mr. P. Alex. Peterson tells how various difficulties were overcome in replacing temporary with permanent roadbed. *The Engineering News* (Nov. 28) extracts some examples from his speech. The first is "Trestle No. 226 A, 1,248 miles west of Montreal, a pile trestle 335 ft. long and 8 ft. high, crossing a soft spot in a swamp. Had the bottom been firm, only 2,880 cu. yds. of filling would have been required, but soundings were taken through black muck and soft clay for 60 ft. without finding a hard bottom. When 6,912 cu. yds. had been put in, the track dropped 4 ft. on the whole line of the trestle. Filling was continued, but, when 54,600 cu. yds. in all had been put in, the filling sank faster than it could be put in," the track falling as much as 11 ft. below grade. The track was raised by sawdust filling, which has remained in perfect order. Trestle No. 169 was filled entirely with sawdust with slopes 3 to 1. The sawdust was covered with a foot of ballast, and, after settling had been followed up on a 75-ft. section for three months, the sawdust remained permanent. It may be interesting to know that the sawdust bank yields less under a passing train than the trestle, and has less spring in it than a muck bank, over a swamp of the same character. Trestle No. 177 was on piles driven into 20 to 40 ft. of soft mud. Settling was constant and serious while "filling in" was in progress, and until the new material had replaced the mud. At various points on the line settlements of 40 and 52 ft. have taken place, owing to sliding of the mud into the lake bottom. Some settlings are difficult to account for. When foundations are good, the filling of a large trestle is accompanied with little or no risk, and the considerations are principally those of cost. "The material used on the eastern and western divisions was loaded with steam shovels on flat cars, and unloaded by means of the ordinary ballast plow drawn over the length of the train by the locomotive." A pneumatic dumping device was afterward adopted, doing away with man labor. "Two large embankments, one containing 66,000 yds. and the other 144,000 yds., have been made by sluicing gravel from adjoining hills. The first embankment was filled at a cost of $5,839, of which $2,862 was for labor and the balance was for plant and material used in boxes, etc. Charging 20 per cent. of cost of plant against this filling reduces the cost per cu. yd. to 7.15 cents. In the second filling the water was carried in a 15-in. pipe under 125-ft. head to a giant or monitor such as is used in hydraulic mining, having a 5-in. nozzle. The gravel and water is led off in a flume having a grade of 11.5 to 25 per cent. This stream will carry down on to the dump 750 cu. yds. in 10 hours.

In another article in the same number the editor gives a number of examples of the filling in of trestles. In this connection he says: "Returning to the question of comparative cost of permanent earthwork construction in the first place, and temporary trestling, followed later by permanent earthwork, it may be noted that in a report on the physical condition of the Lake Erie & Western Railroad in 1894 it is stated that the cost of standard frame or pile trestles, say, 15 ft. in height, is about $7 per foot run, and their average life is nine years. The cost of permanent structures where iron-pipe culverts or stone arches can be used, and the height does not exceed 15 ft., is said to be but little more than the cost of a trestle, and seldom exceeds twice the cost, including the cost of filling the opening with earth. For longer openings, where plate girders and masonry are necessary, the cost is little more than twice, and seldom exceeds three times, the cost of a trestle. The cost of filling with a steam shovel and an 'unloader' plow, in 1894, was about 12 to 14 cents per cu. yd., including wages of train crew and laborers, fuel, oil, waste, and repairs." An example showing the comparison in detail is here given:

First construction:	
Earthwork (at 28 cts.)	$27,042
Openings in bank	28,000
Total for permanent const.	55,042
Trestle, cost of	11,708
Saving in first cost by trestle	43,334

Gradual construction:	
Trestle	11,708
Filling trestle (at 10 cts.)	9,658
Openings in bank	28,000
Total	49,366
Saving over earthwork ($55,042)	5,676
Comp. int., 8% on $28,000, 6 yrs.	16,432
" " " " 9,658, 4 "	3,481
" " " " 5,676, 6 "	3,331
Saving by trestle replaced by bank	28,920

Taking the cost per 1,000 ft. B. M. of timber at $40, and the total cost of iron, foundation, engineering, etc., at $53.90, we have the following relation for various heights of trestle:

Height, ft.	Lumb'r B. M., per 16 lin. ft.	Cost of trestle, at $53.90 per M.B.M.	Bank, 16 ft. lgth., 10% shr'kge cu. yds.	Cost of bank, at 28 cts. per cu. yd.	Ratio of cost of trestle (1) to b'nk.
17	1,941	$104.60	415.6	$116.36	1.11
22	2,201	118.62	645.3	180.69	1.51
27	2,665	143.65	924.0	258.72	1.80
32	2,964	159.76	1,251.6	350.94	2.20
37	3,478	187.46	1,628.0	455.84	2.43
42	3,808	205.25	2,053.3	574.83	2.80
48	4,392	236.73	2,628.3	735.80	3.11

Economy in an Electric Road Power-House.

In a paper read before the Street Railway Association of the State of New York by Mr. H. S. Newton, and published in *The Electrical Age* (Nov. 9), an opinion was presented to the effect that all modern power-houses should be installed with an idea to maximum economy. To this end experiments have been in progress at the Syracuse Street Railway Company's plant, which derives its power from three upright double compound engines with 16½ × 31-in. cylinders and 24-in. stroke. The steam from these engines exhausts into a surface condenser, and the water of condensation is "pumped through an oil filter or separator into a hot well, from which the boiler feed-pumps convey it through a pipe-heater to the boilers. By this arrangement, not to exceed ten per cent. of the boiler feed-water is taken from the outside water supply, and all difficulty with scale is practically overcome." Five to ten degrees temperature were saved by covering the feed-water pipes with insulating material, while the life was increased and rattling of the boiler check-valve was prevented by the introduction of another check-valve just beyond the pump, and the use of an air chamber. The use of an auxiliary injector for each boiler is recommended, as the pumps usually need frequent repairs. The character of Syracuse water made it desirable to use the condensed steam from the condensers, and ninety per cent. of the feed water is derived from this source. After a great deal of experimenting with the dark brown sediment which persisted in caking on the bottom sheets, the following causes were discovered: "(1) The use of too much cylinder oil; (2) the use of the wrong kind of cylinder oil; (3) insufficient filtration of the oil from feed-water before going to the boiler." Following these conclusions, but three drops of oil per minute were allowed per engine cylinder; purely mineral stock oil was used with the most satisfactory results; vertical partitions, causing flow over one and under the next one alternately, were introduced into the filter, which facilitated the catching of dirt and oil by the excelsior. These remedies were effective, and no trouble is now experienced from the caking of oil scum in the boilers. The cheapest fuel was found to be buckwheat anthracite coal, and mechanical devices are used for its handling and regulation in preference to trusting to hand labor. "We have found that the less responsibility you place in the man who shovels in your coal, the better off you are in the end." The vertical engines are somewhat noisy, as the cross-heads must be kept loose in the guides to prevent heating. Much importance is attached to constant and well-governed speed in the engines, as several per cent. of the loss in transmission of current may thus be saved. "In conclusion, I cannot refrain from adding one more voice to the cry against cheap labor in the power-house. Our present engineer in charge was employed by me after a very close demonstration that a cheap man was not capable of handling the plant."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Technical Journals—See Introductory.

*2468. Are American Railway Rates Too High? H. T. Newcomb (An analytical comparison of the rates of travel and transportation prevailing at different periods of this country's history, and a consideration of the causes operating to raise or lower these rates). Eng Mag–Jan. 3700 w.

2530. Improvements in Freight Car Trucks. Ill. (Designs of cast steel and rolled steel I beam truck frames, having in consideration economy of first cost, simplicity, durability, and facility for repairs). R R Car Jour–Nov. 1100 w.

2531. Church & Ettenger's Truck for 60.000 lbs. Capacity Car. Ill. (Design for a diamond frame freight car truck, by an English firm, resembling in most respects American practice. The truck and bolsters are adapted to tubular frame car construction). R R Car Jour–Nov. 900 w.

2532. Drawing Office Method. J. R. S. in "New York Railroad Men" (An outline of methods used in practice respecting indexing drawings, scales, tracings, numbering drawings, etc). R R Car Jour–Nov. 600 w.

2533. Refrigerator Car; Merchants' Despatch Transportation Company. Ill. (Description with detail drawings). R R Car Jour–Nov–1600 w.

2534. Cost of a Passenger Car (Detailed and itemized cost sheet giving the number of pieces of each article entering into construction and fitting, with labor required at a total cost of $4411.67). R R Car Jour–Nov. 2800 w.

2535. An English View of American Railroad Cars Jeremiah Head (Extract from a paper read before the Cleveland Institution of Engineers showing the superior conveniences and comfort of American cars, and though the dead weight is comparatively greater on American roads for passenger traffic, it is less with freight). R R Car Jour–Nov. 1600 w.

2540. A National Classification of Freight (Presented before the National Asso. of Agricultural Implement and Vehicle Manufacturers. Reasons *pro* and *con* relating to improvements in freight classification). Ry Rev–Nov. 9. 1500 w.

2541. Improved Automatic Trap for Indirect Car Heating. Ill. (A trap operating on the same principle as the compensating pendulum, letting in hot-water or steam only after the temperature lowers). Ry Rev–Nov. 9. 700 w.

2543. A Speed of One Hundred Miles an Hour. G. T. H. (Consideration of the requirements to attain such speed, and the points of superiority of electricity presented). Elec Ry Gaz–Nov. 9. 1000 w.

2546. A Plea for the Motorman. A. E. D. (The importance of the motorman's work, the need of appreciation, desirability of attracting a better class of men, etc., with comments on the work). Elec Eng–Nov. 13. 1700 w.

2556. No Seat, No fare, in Europe. C. L. Bonney (Report made to the Mayor and city council of Chicago. Brief account of transportation interests in London, Berlin and Paris, with remarks on joint use of tracks and municipal ownership). Elec–Nov. 13. 2200 w.

*2572. The Continuous Rail in Street Railway Practice. Ill. Richard M'Culloch (A valuable paper which was read before the Eng.'s Club of St. Louis, giving a history of methods for welding rails with a description of the two practicable methods in operation, *i. e.*, electric welding and cast welding. The author concludes that the plan has given perfect satisfaction where adopted). St Ry Rev–Nov. 15. 6300 w.

2574. Conduit Electric Railway at Madras, India. Ill. (A railway that is interesting as being the first electric in India, and also because it is constructed on the conduit system. The outer rail is of the grooved girder type, while the conductor is an insulated T rail). Eng News–Nov. 14. 300 w.

2576. Tracklaying on the Minneapolis, St. Paul & Sault Ste. Marie Ry. in 1893. Ill. (A complete detailed description. Several devices are shown in the inset illustration for facilitating rapidity of handling of ties, spikes, bolts, plates, &c. The labor and expense account are given along with other valuable details). Eng News–Nov. 14. 2800 w.

2583. Emergency Brake Problem. Walter E. Harrington (Records of tests made by the writer with conclusions drawn at the time). W Elec–Nov. 16. 1500 w.

2592. Some Notable English Engines. Herbert T. Walker (A description with illustrations of five engines of various types used on English railways. The wheels and boiler were painted bright green, the frame red, and they abounded in polished brass parts. A diagram is given showing the comparison boiler heights, from 2 ft. 8 in. above rails in an English engine, to 8 ft. 11½ in. in No. 999 of the new York Central railroad). R R Gaz–Nov. 15. 2700 w.

*2599. The Hörde Conduit System. Ill. (The aim has been to construct a conduit strong, cheap and easily accessible for repairs. Descriptive). Elec Rev, Lond–Nov. 8. 1400 w.

2615. Car Ventilation (An editorial upon the importance of fresh air in railway cars, and how to secure this without draughts, cinders and other annoyances). Am Eng & R R Jour–Nov. 14. 3800 w.

2616. Car Ventilation (Abstract of a paper by S. H. Woodbridge, of the Mass. Inst. of Technology, giving the requirements in car ventilation and stating that if pure air is introduced there will be no trouble in expelling the vitiated air). Am Eng & R R Jour–Nov. 14. 600 w.

2617. Electric Cable Railway up the Stanserhorn (A three section cable line in the Alps, having a length of 13,124 ft. and a difference in elevation of 1400 ft. ; it is operated by electricity generated by water-power). Am Eng & R R Jour–Nov. 14. 1000 w.

2620. The Breakage of a Locomotive Driving Axle on the Great Northern Railway of England (Abstract of a report to the Railway Dept. of the Bd. of Trade. Description of the accident showing that there was a previous crack in the axle, inside the hub, and discussing the methods of testing for such imperfection. The axle within the hub is now made of greater diameter than the remainder, which was not the case in the English engine mentioned). Am Eng & R R Jour–Nov. 14. 2100 w.

2621. The First Steam Locomotive. From *English Mechanic* (Description, with cut, of a practical locomotive antedating George Stephenson's *Rocket* by nearly thirty years. It was designed by Richard Trevithick). Am Eng & R R Jour–Nov. 14. 1200 w.

2622. October's Heavy Railroad Earnings (The article gives the October earnings of 1894 and 1895 for each of the 125 roads in the United States and Mexico, showing a gross increase of 6-8 % over 1894. The gross October earnings amounted to $54,837,075). Bradstreet's–Nov. 16. 1000 w.

*2629. The Brighton and Rottingdean Seashore Electric Tramroad (The roadbed is under water a considerable portion of the time, and so the car is mounted on a framework 23 feet above the rails. The power proposed is electricity. The line will be used for passenger traffic). Eng, Lond–Nov. 8. 800 w.

*2630. Railway Economics (Editorial comments on a series of lectures by Mr. Acworth on "Railway Economics" before the Society of Arts. The article disagrees with the opinions of the lecturer and says that technical education is not a necessity in railroad management and operation). Eng, Lond–Nov. 8. 2200 w.

*2631. New South Wales Government Railways and Tramways. Ill. (An exhaustive article embracing maintenance of way, construction, rolling stock, traffic department, safety appliances, etc. Illustrations of locomotives and cars are given). Eng, Lond–Nov. 8. Serial. 1st part. 3300 w.

2646. A Trip on the Baltimore Electric Locomotive (Descriptive of some novel features not previously noted). Elec Ry Gaz–Nov. 16. 1200 w.

2647. E. M. Traction System. Ill. (A brief description of the method adopted by James F. McLaughlin of Philadelphia). Elec Ry Gaz–Nov. 16. 1000 w.

2648. Overhead Feeder and Trolley Construction of the New Orleans Traction Company. Map. W. Nelson Smith (A line interesting because of its size and the peculiar conditions prevailing). Elec Ry Gaz–Nov. 16. 1700 w.

*2677. A Running Shed : Its Work and Experiences. A. E. Lockyer (Illustrated from numerous photographs showing the method of cleaning engines, washing out boilers, inspection and repair of engines and wrecking trains, with description). Ry Wld–Nov. 3000 w.

*2678. Bristol Electric Tramway. Ill. (A British electric city railway of American design but with important modifications. The trolley wire supports are ornamental iron posts, carrying also the electric street lamps. There is a complete description of power plant, rolling stock, permanent way and management). Ry Wld-Nov. 4800 w.

2679. Mileage of Railway in European Countries (Interesting information from the report of bureau of railways of the French government. The mileage of each European country at the end of 1894 is given with the increase over the previous year. Russia heads the list with an increase of 1212 during 1894). Ry Age-Nov. 15. 350 w.

2684. Tests of Signal Pipe Connection (These tests were made on galvanized and ungalvanized iron pipe, one inch diameter, for the purpose of determining whether galvanizing affects the strength, and also to find what the strength limits will be. Specimens were two inches and twelve inches long). Ry Rev-Nov. 16. 400 w.

2685. Mitre Rails. Jerry Sullivan (Comment on the report of committee of the Roadmasters' Association of America. Splitting of the end of the rail along the web and hammering of the head at the joint was ascribed to the rigid joint caused by too solid tamping of the adjacent ties). Ry Rev-Nov. 16. 1300 w.

*2689 A great American Railway (Report of a very entertaining interview with Col. Taylor, the London representative of the Pennsylvania Railroad, giving many items of interest not generally known). Trans-Nov. 8. 1400 w.

2716. Service Record of the Richmond Compound. W. R. Trigg (A table showing the comparative performances of simple and compound locomotives. The compound type saved 24.5 % of coal, and 7.9 % in repairs). R R Gaz-Nov. 22. 350 w.

2717. Intercepting and Reducing Valves of the Rogers Compound Locomotive (The description is detailed and illustrated by sections. They are used on a passenger locomotive built for Chile). R R Gaz-Nov. 22. 1200 w.

2718. The New Four-Cylinder Compound Locomotives of the Paris, Lyons and Mediterranean (Locomotives with new features such as an air cutting front and having cylinders in same horizontal plane. Full particulars are shown on drawings). R R Gaz-Nov. 22. 900 w.

2719. An Inspection Car for the M. K. & T. Ill. (An open car carrying six persons at a speed of 35 miles an hour). R R Gaz-Nov. 22. 400 w.

2720. Painted or Planished Iron Jackets for Locomotives. E. E. Russell Tratman (A paper before the New York Ry. Club, giving the experience and practice of a number of roads, showing that painting iron is not only cheaper in first cost, but that it has a longer life than planished iron). R R Gaz-Nov. 22. 1800 w.

2721. Solid Bridge Floors of Old Rails (Girder bridge construction on the Chesapeake and Ohio. Sections and detail drawings accompany the article). R R Gaz-Nov. 22. 600 w.

2722. Joint Traffic Association Agreement (An agreement in full, entered into by the Presidents of the Trunk Line and Central Traffic Association, on Nov. 19, to establish traffic standards). R R Gaz-Nov. 22. 2700 w.

*2740. Horseless Tramways (An excellent article abstracted from the *Pall Mall Gazette*, comparing the mileage, receipts, expenses and profits in steam, horse, cable and electric lines in Gt. Britain. In Birmingham the cable road gave far the largest profits). Prac Eng-Nov. 15. 800 w.

†2746. Light Railways (A British Consulae Report on Hungarian light, secondary railways showing that but eight out of sixty have paid dividends and the total percentage deficit has been, in 1892, 11.09%). Ind & East Eng-Oct. 26. 700 w.

2752. The Cleveland Disaster. Ill. (An account of a car plunging through the open drawbridge of the Central Viaduct, and falling 100 ft. into the river, causing the death of many persons). Elec Ry Gaz-Nov. 23. 700 w.

2754. The Pennock Steel Car. Ill. (A 30-ton capacity flat top freight car made entirely of steel. Not a particle of cast iron or wood has been used in its construction, and the weight is 2 to 4 thousand less than a similar wooden car). Ry Rev-Nov. 23. 900 w.

2755. Important Air Brake Decision (The claims, argument and opinion of the court in the infringement suit between the Westinghouse Air Brake Co. and the Boyden Air Brake Co. Considerable information is embraced in the arguments on destruction). Ry Rev-Nov. 23. 8000 w.

2757. Building Temporary Trestles. Ill. (A paper read before the Assn. of R. R. Supts. of Bridges and Buildings on methods of handling wrecks, replacing trestles, bridging wash outs, and expedients for similar emergencies). Ry Age-Nov. 22. 3800 w.

*2761. The Continuous Rail in Street Railway Practice. Richard McCulloch (Description of method and apparatus in both electric and cast welding, with the results of experiments, calculation of strains and comparison of methods. Examples of both these methods, are in actual operation, furnishing a good ground line electric conductor, and costing little more than fishplate joints). Jour Asso of Engng Soc-Oct. 6000 w.

*2765. High Speeds in the United States (Editorial comment on the Lake Shore train speed record. The writer is doubtful as to the possibility of such fast time and asks how it was done). Eng, Lond-Nov. 15. 1500 w.

2788. Air Brakes on Freight Trains. A. M. Waitt (Abstract of a paper read at the Nov. meeting of the West. Ry. Club on the details of operation of air brakes. With editorial). R R Gaz-Nov. 29. 4600 w.

2791. The October Discussion of Block-Signal Rules (Some editorial criticism of the work of the committee of the Amer. Ry. Assn. on block-signal rules, with numerous notes and some references). R R Gaz-Nov. 29. 1900 w.

*2792. The Reconstruction of the Canadian Pacific Railway (Brief history of the enterprise and illustrated description of difficult and interesting details of the work). Engng-Nov. 22. Serial. 1st part. 2500 w.

*2794. American Express Locomotives (Tabulated statement of dimensions and performance of locomotives 599 and 564 in the recent races from New York to Buffalo, and Buffalo to Chicago). Engng–Nov. 22. 1700 w.

2802. The Canadian Pacific Railway, as Seen by an Engineer. Thomas C. Clarke (A description of the organization, capitalization, operation, and points of engineering interest of the road. Twenty thousand men are employed and there is always a surplus in the treasury). Eng News–Nov. 28. 2500 w.

2803. Replacing Trestles with Earthwork (Editorial. A detailed comparison as to cost, expediency, etc., of various forms of railway trestles with embankments. Some valuable data is given). Eng News–Nov. 28. 3000 w.

2804. Replacing Trestles with Earthwork; Canadian Pacific Ry. P. Alex. Peterson (Filling in of Trestles and similar replacement work. The subject of a paper before the Canadian Soc. of Civ. Engs.) Eng News–Nov. 28. 3000 w.

2805. Standard Highway Bridge of Steel Rails; Baltimore and Ohio R. R. (The cost of these bridges is less than for wooden structures. They are otherwise perfectly satisfactory. Drawings of side and end elevation are given). Eng News–Nov. 28. 300 w.

2870. An Important Car Coupler Decision (A case in the U. S. circuit court, Gould Coupler Co. vs. Pascal P. Pratt et al. The Browning, Hein, Prior, Barnes, etc., patents are discussed in the article. Also editorial comment). Ry Rev–Nov. 30. 5200 w.

2871. Interlocking Work on the Metropolitan Elevated of Chicago (An illustrated description showing arrangement of switches, signalling apparatus, and lift drawbridge device). Ry Rev–Nov. 30. 1500 w.

2872. Electric Railways (An editorial stating that though trolley lines are in operation but seven years, there are now over 800 trolley roads. Some recent advances are noticed). Am Eng & R R Jour–Nov. 28. 900 w.

2873. Railroad Racing (An editorial advocating lighter cars as an element toward obtaining higher speeds). Am Eng & R R Jour–Nov 28. 2000 w.

2874. The Most Advantageous Dimensions for Locomotive Exhaust Pipes and Smoke-Stacks. Inspector Troske(Paper read before the German Soc. of Mech. Engs. giving the conclusions of late observations). Am Eng & R R Jour–Nov. 28. Serial. 1st part. 3000 w.

2875. The Docteur Brick-Lined Fire-Box (This locomotive boiler with copper sheet and tubes is used on a Belgian railway, with very satisfactory results. The new brick-lined fire-box saved 33⅓% in fuel). Am Eng & R R Jour–Nov. 1700 w.

*2896. Wood Working Machinery for Locomotive Work. W. H. Weston (Showing the advantages to be gained by using various wood-working machines in preference to hand labor. Speed, more perfect duplication of parts, and economy are claimed for the machines). Nat Car & Loc Build–Dec. 1800 w.

*2897. The German Kaiser's Train (A twelve car train costing over half a million dollars. Half tone views of the interior of the private car are given). Nat Car & Loc Build–Dec. 200 w.

*2913. Railroading in South Africa. Philip E. Stillwagen (A practical letter from a practical man. The details of operating, wages, etc. for the Netherlands Railway Co. are given; the road pays an 85 per cent. dividend). Loc Engng –Dec. 2500 w.

†2918. The Lexington Avenue System of the Metropolitan Street Railway Company, New York. Ill. (This line was put in operation on Oct. 13. Its present length is about four and three-fourths miles, though it will be extended later to about six miles. The road, which is now run by cable will ultimately be equipped with the underground electric conduit system). St Ry Jour–Dec. 3000 w.

†2919. Power Station Records of the Montreal Street Railway Company (A tabulated statement, with explanation, for the year ending Sept. 1895). St Ry Jour–Dec. 800 w.

†2920. A Comparison of British and American Local Transportation Practice (A table giving the population, tramway mileage, and passengers carried in 19 principal cities in America and England, indicates that in America there is 1500 population to every mile of tramway, while in England there are 7000 per mile in the cities quoted). St Ry Jour–Dec. 1200 w.

†2921. Proposed Electrical Construction of the Metropolitan Street Railway Company, New York (Illustrated description). St Ry Jour–Dec. 1200 w.

†2922. Track Construction without Ties in Toronto (Sections of track are shown). St Ry Jour–Dec. 100 w.

†2923. Brakes on Street Cars (An article arguing that with high speeds, mechanically operated brakes are necessary as the work is too severe for the motorman to perform satisfactorily). St Ry Jour–Dec. 1300 w.

2943. A Simple Electric-Locking Circuit for Interlocked Crossings. N. H. Elliott (Condensed from a paper read before the Railway Signalling Club). Eng News–Dec. 5. 1400 w.

†2958. Interlocking Loop Facing Points (Illustrated description of a new invention). Ind & East Eng–Nov. 2. 1400 w.

†2959. Light Railways and Tramways. R. H. Dorman (A paper read before the Incorporated Asso. of Munic. & County Engs. of Londonderry. The method of construction of such railways in Ireland are fully described). Ind & East Eng–Nov. 2. Serial. 1st part. 2000 w.

2983. New Freight Switching System of the Illinois Central (Description of the method of designating divisions; the switching rules are given in full). Ry Age–Dec. 6. 1300 w.

3001. Reparation under the Act to Regulate Commerce—Opinion and Order of the Commission. The opinion is given in full; also editorial). Ry Rev–Dec. 7. 5700 w.

3002. Snow Shed Fire Protection (A description of the fire trains and the system of preventing and extinguishing fires in Southern Pacific sheds). Ry Rev–Dec. 7. 1700 w.

SCIENTIFIC MISCELLANY

Injustice to Technical Men.

In an address recently delivered before the Technical Society of the Pacific Coast, by Mr. Geo. W. Dickie, at an informal meeting held October 5, and reported in part in *American Machinist* (Nov. 7), he divides investigations of natural phenomena into classes,—the "scientific" and "technical." Presumably he means also to range investigators in like manner; this presumption seems warranted by his definition of the adjectives "scientific" and "technical" as applied to investigations.

"Those investigations that are of no immediate use are scientific, while those that have immediate application to some industry, or satisfy some want, are technical." Of course, Mr. Dickie means by investigations effort—experimental or otherwise—systematically and intelligently directed to the finding out of that which is not known, or toward the verification or disproval of previously-announced results or data. A great deal that is called investigation would, under this restriction, be neither scientific or technical, since it is purely and simply misdirected effort. A great deal of such effort has been put forth in attempts to construct a machine capable of self-motion, commonly, but not accurately, called perpetual motion. We suppose an effort of this sort would not be considered by well-educated men either scientific or technical.

Making no quarrel with Mr. Dickie's definition, we pass to the key-note of his address, which is, substantially, that an injustice to technical men is committed by the general public in permitting the scientist to outrank the technician.

"Is it not curious that the world should honor those men whose life-work has no bearing whatever on man's physical requirements or the extent of his resources, and has but little admiration for those whose lives have been spent in devising means whereby the burdens of humanity are lightened. The world places the philosopher in the top row of the scientific benches, while the mechanic is relegated to the lowest forms in the technical class. He who stumbles upon or discovers a new element in some of nature's laws stands infinitely higher in the eyes of the world than the mechanic whose labor has produced work that has lightened the labors of millions of his fellow-men.

"I think this may be taken as a strong proof of the inherent intellectuality of men. Yet, when we consider the fact that the greater part of the world labors under constant and unavoidable necessity of providing itself with daily bread, and never loses an opportunity to protest against the imposition, it would seem that one who seeks to relieve the burden of toil by the invention of labor-saving implements would gain the gratitude of his fellowmen. Yet I do not know that the technical man deserves any better fate than has befallen him. His ambition is of the earth, earthy. He deals with things, instead of with ideas, and therefore gets his reward from things, and not from men. His days are passed in close offices or dreary workshops. He has no delight in nature, except so far as she will help him turn his wheel. He concentrates his whole being within some little trade circle. From dawn to dark the technical man lives and moves and has his being in iron, steel, wood, leather, or whatever other thing he makes or vends, and he often carries these things to his home, to make a technical shop of that sanctuary; tries to make a reputation by discussing them at the Technical Society with other technical people; and is sadly disappointed when the world takes no notice of him."

Now, aside from the question whether a man who investigates the laws of nature simply as a noble intellectual pursuit is not working upon a higher plane than one who seeks to discover something with the sole purpose of putting money in his purse, let us come to the question of fact raised by Mr. Dickie in his address.

"If the question be asked in a miscellaneous collection of educated men : 'who invented the locomotive?' it is almost certain that George Stephenson would be the name given ; and doubt would be expressed, if any one should explain that he only added a little to the labors of others in the same field. Yet amongst that same collection of men it would be a sign of a want of education and culture not to be acquainted with the works of Kepler, Bacon, Newton, Davy, Faraday, Darwin, and many others that have contributed to the sum of human knowledge, but whose work, at least at the time it was done, had but little promise of material help for humanity."

Is it a fact that scientists, pure and simple, are more generally known and honored than technicians? It is true that, as compared with what had been previously done, Stephenson added only a little, but what is little in comparison with some particular standard may be very great when compared with another standard, and the success which Stephenson achieved, demonstrating as it did to the world the practicability of steam locomotion on railway tracks, marks an epoch in the world's progress. It is as true of every scientific advance as it is of Stephenson's locomotive —when viewed from the same standpoint —that it adds but "a little to the labors of others in the same field." The year that has passed has brought to public notice a great discovery,—that of a new atmospheric constituent; but, compared with the labors of others in the study of gases, the composition of air, and of the physical qualities which enable it to be liquefied, the discovery of argon (which will immortalize and ought to immortalize its discoverer) is only a small addition. If air had never been liquefied, in all probability science would yet have remained ignorant of the existence of argon. Anything that any one man, however great, can do or discover must of necessity be a small thing as compared with all that has been done and discovered in that field, or as compared with the entire extent of the field. A man is great, when his work and influence confer public benefits conspicuously above the results of contemporaneous work. Judged by this standard, his work receives honor, and his name becomes famous or otherwise. And this is the only practicable standard by which men, whether their rank be literary, scientific, philosophic, technical, political, or artistic, can be rated.

The work of the rank and file of scientists, though much of it is good, honest, and painstaking, and though it all forms part of what has been done, will be, in the future, as much ignored as that of the technical workers who preceded Stephenson, but who did not produce a successful steam locomotive. The same will be true of the rank and file of technicians. Those whose work towers up will be held in remembrance. In the future record of great men, the names of Westinghouse, Edison, Bell, and Bessemer will as surely find a place as the names of Kepler, Bacon, Newton, and Davy. And among the "ladies of society" and the "miscellaneous collection of educated men" (?) who know little or nothing of the history of the spinning jenny or of the steam engine, we should expect to find the same ignorance of the scientific work which preceded the work of Kepler, Bacon, and Newton, or of the work of these three great men themselves. How many in, say, one thousand of such people could tell us what was the work of these men whom they honor as great, not because they know anything of their work, but because those supposed to know have agreed to call them great?

The Thermophone.

ONE of the best popular descriptions of this new instrument for determining temperature which we have yet seen is given in *Science* (Nov. 15). The following is an abstract.

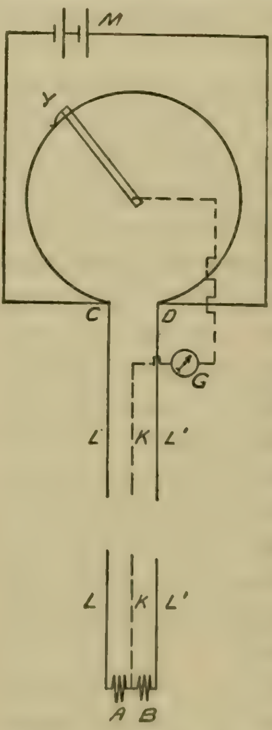
The instrument was invented by Mr. Henry E. Warren and Mr. George C. Whipple, who gave an account of it at the Summer School of Civil Engineering of the Massachusetts Institute of Technology during last summer's session. Since that time its possibilities have been much discussed in scientific circles.

The operation of the thermophone is based upon the principle that the resistance which a conductor offers to the passage of an electric current depends upon its temperature, and advantage is taken of the fact that different metals have different electrical temperature co-efficients. Thus the resistance of a copper wire increases about one per cent. for each 5° F., while in the case of German silver the increase is only about one tenth as great. It is a curious fact that the co-efficients of most pure metals are almost the same as that of copper; but alloys have co-efficients which are much lower.

The arrangement of the electrical parts of the thermophone is shown in Fig. 1. Students of electricity will recognize it as a modification of a Wheatstone's Bridge. Two coils of resistance wires, *A*, *B*, one of which is copper and the other German silver, are made to form two arms of the bridge. These two coils are joined, and placed at the point where the temperature reading is desired. They are usually drawn inside a long brass tube of small diameter, coiled into a helix and hermetically sealed, the space between the wires and the walls of the tube being filled with oil to prevent corrosion and to hasten the transmission of heat between the outside of the tube and the resistance wires. The sensitive coils are connected by the leading wires, *L* and *L'*, to the ends of a circular slide wire, *C*, *D*, and at these points connection is also made with the battery, *M*. A third leading wire, *K*, extends from the junction of the two coils to a movable contact, *Y*, on the slide wire. In this circuit there is interposed either a galvanometer or a telephone in connection with a current interrupter, the latter being operated by an independent battery connection. This combination of telephone and current interrupter is used in all the portable forms of the instrument, and has been found to be a very cheap and efficient substitute for a galvanometer. The presence of a current is indicated by a buzzing sound in the telephone; silence corresponds to the "zero deflection" of a galvanometer.

Bearing in mind the principle of the Wheatstone's Bridge, it will be seen that the galvanometer will indicate "zero deflection" when A:B=CY:DY. The coils, *A* and *B*, being made of metals having very different temperature coefficients, will vary in resistance at different rates as their temperature changes, and consequently there will be a different value of the ratio of *A* to *B* for each degree of temperature. Thus it will be seen that, with the bridge balanced, there must be a different position of the contact *Y* for every degree of temperature, and a graduated scale may be constructed corresponding to the temperature of the sensitive coils.

The operation of taking a reading with the thermophone is as follows: The helix containing the sensitive coils being placed at the point where the temperature is desired, and the leading wires being connected to the binding posts of the indicator box, the current is turned on, and the telephone held to the ear. A buzzing sound in the telephone is found to increase or diminish as the hand is made to approach or recede from a certain section of the dial. By moving it back and forth, a position may be found where the telephone is silent. When at this point, the hand indicates the temperature of the distant coils. The instrument is extremely sensitive. An inexperienced observer may easily set it to one-tenth of a degree. With special instruments having a small range, it is possible to make readings with much greater precision.



The application of this instrument to the determination of temperature of water at different depths has been entirely successful. The temperatures of water at different points in Lake Champlain have thus been determined and charted. It has also been found that steel-tape measurements of distance can now be made with great accuracy, the data for corrections for expansion by heat and contraction by cold being supplied readily by the thermophone.

A Romance of Modern Industry.

AN extremely interesting article in *The Iron and Coal Trades Review* (Nov. 15) gives an account of the commercial rise and fall of the Castner process for obtaining aluminum, and of its salvation as a commercial enterprise by a diversion from its original purpose. An abstract of this account is here presented.

Some twelve years ago a young American chemist landed in London with certain ideas as to the possibility of improving the Deville process for the manufacture of aluminum, founded on laboratory experiments that he had made in New York, where he had resided up to that time.

In London he made the acquaintance of distinguished and influential men, who were convinced of the value of the discovery. A company was formed and works erected at Oldbury, near Birmingham, for carrying on the process on a commercial scale. At that time no works were in existence in this country for the manufacture of aluminum on a commercial scale, although the late Mr. Webster had succeeded in cheapening the method then employed for the production of the chlorid of aluminum. The cost of production of aluminum by the Deville process was not less than 40s. per pound, and such aluminum as could be purchased was seldom sold for less than 60s. per pound; but, owing to its high price, and the very limited extent to which it was produced, it was scarcely used in the arts, and such quantities as were available were mainly drawn from France.

Mr. Hamilton Y. Castner, the young chemist referred to, made several important improvements in the Deville process, tending to reduce the cost of producing aluminum from 40s., or more, to about 15s. per lb. The Castner process was based on several reactions: first, the preparation of pure aluminum from alum, bauxite, or clay; secondly, the production of the double chlorid of aluminum and sodium from the alumina prepared in the first operation; thirdly, the production of metallic sodium; and, fourthly, the reduction of aluminum from the double chlorid by the use of sodium. The latter metal, therefore, played a very prominent part in the process, one of the most important features of which was that it gave a practically unlimited supply of a product that was formerly little more than a laboratory curiosity.

The plans were prepared for the erection of the Oldbury works on an extensive scale. At that time there were not more than 50 lbs. of aluminum produced per day in the world; but these works were built of a capacity to turn out 500 lbs. per day, and 1,500 lbs. of sodium, reducing the price of the latter from 6s. to 9d. per pound.

In the third year of the existence of this company it was announced that the Pittsburg Reduction Company had succeeded in reducing alumina by electrolysis, and had thereby brought down the cost of producing aluminum from 15s. to less than 3s. per lb., or, in other words, had reduced the cost of production to about one-fifth of what it was under the Castner patents. The new process consists in passing the electric current through a bath of fluorine, which is kept molten by the heat of the electric arc, between a number of carbon rods and the carbon lining of the vessel, in which alumina, or aluminum oxid, is held in solution. The decomposition of the alumina is thus attained, and electrolysis takes place, with the result of producing pure alumina. Of course, as a method for the production of aluminum, Castner's system was entirely swamped by the electrolytic process, but the process for the production of sodium still remained. At that time, however, there was almost no demand for sodium as such. This demand had to be created. The company laid itself out for doing so, but the work was slow and tedious, and it was not until last year that the company were in a position to announce that the sodium process had so far succeeded as to allow of a dividend being paid on the capital of the company, which had in the meantime been reduced from £345,000 to £100,000, so as to meet the altered circumstances of the times.

When the aluminum business of the company collapsed, the shareholders were completely discouraged at the prospect of a complete loss to their investments. But Mr. Castner seems to be made of better than the average stuff, and he still sets his face toward progress. Combined with large chemical knowledge and experience, he has ability for original research and great perseverance, and, although it was not in any way due to him that the collapse of his process had occurred, he applied himself to devise ways and means to extricate the Aluminum Company from its difficulties. The special line of research to which he proceeded to devote his attention was the production of caustic soda and bleaching powder by electrolytic methods. Previous experimenters had worked in this field with results that were not at all satisfactory, and the bulk of the caustic soda ash produced in the United Kingdom continued to be produced by the process discovered by Nicolas Leblanc in 1791, which yields both soda and hydrochloric acid, but is more expensive to work than the Solway process, which has become its competitor, and has largely superseded it for soda ash, although not for caustic or bleaching powder. Mr. Castner's experiments led him to adopt as the essential feature of his process a moving body of mercury, which completely separates the products of the electrolysis, and takes the place of a diaphragm, the amalgam formed by the electric action being decomposed electrically as rapidly as it is so formed. The process is a continuous one, and yields an electrical efficiency of between 80 per cent. and 90 per cent. without production of hypochlorites. The process yields by direct evaporation a solid caustic of 99½ per cent. At the Oldbury works the Aluminum Company is said to have now carried on the process for about a year with satisfactory results, on a sufficiently large scale to thoroughly test its value, the plant having a daily output of about 1,200 lbs. of pure caustic soda and 1,000 lbs. of chlorine. The process has now been carried to a point where its further development has become inevitable. The directors of the Aluminum Company have, therefore, made arrangements for erecting large works to prosecute the new industry. These works will come into direct competition with those of the United Alkali Company, which at present may be said to control the production of both caustic soda and bleaching powder in England.

Mildew, Its Causes and Prevention.

THE following abstract from a recent article in the *Boston Journal of Commerce*, reprinted from the *Textile Mercury*, gives information of interest not only to manufacturers, but to users, of textile goods. Mildew stains are the product of a fermentation caused by moisture and heat, whereby fungi are produced which destroy not only the colors, but, by advanced development, the material also. Whenever wet or moist material is allowed to lie for a length of time in a warm temperature, the conditions are established for the development of mildew, especially when the pieces are piled up in heaps, since pressure prevents access of air.

The development of mildew has three distinct phases. The first is that in which the vegetable growth, yet in a rudimentary state, may be removed by energetic washing, or chlorining, without altering the fabrics. In the second stage the fungus growth can no longer be removed; in spite of all that can be done, the stains remain; but the fabric is not weakened. In the third stage, where the growths have acted upon the fabric, the latter is weakened, even burned. The fabric is irretrievably spoiled, and in strongly affected places it is easy to break it by pressure; and the mechanical action of fulling, washing, and giggin produces holes in such places.

Mildew is most frequently found upon gray or white cotton goods, and white or light vat-blue woolens, which are to be dyed in the piece or to be printed; and there it causes the greatest damage by its resistance to the dyes. Even in the dark indigo-blue dyed hoods mildew stains destroy the color, although not so readily and frequently as in light shades of indigo blue.

Less frequently they appear in goods which are dyed upon boiling baths. It appears, therefore, that boiling of the material to a certain extent protects it against mildew, probably because traces of impurities, such as suint, grease, etc., still adhering to the fiber, are thereby either removed or destroyed, and converted into other less injurious bodies. Besides, the mordants employed for other colors than indigo, such as alum, tartar, sulphuric acid, bichromate of potash, green or blue vitriol, etc., probably act as preservatives. The greater tendency of vat-blue dyed goods to favor the development of mildew is doubtless attributable to the fact that the material is not boiled in dying, and to the nature of the dyestuff itself, which promotes fermentation.

Although mildew is quite often found upon dyed and printed goods, it occurs far more frequently upon pieces of goods in the raw condition as they come from the loom or from the fulling mill, unless they are washed without delay. There is nothing more apt to cause fermentation, and consequently the growth of mildew, than the impurities naturally adhering to the fiber, especially to wool, and those which have been deposited upon it in the course of manufacturing. Remnants of suint, of dye-stuff, wool, oil, glue, or dressing, etc., in combination with moisture, contribute materially to heating the goods, so that in sultry weather, if the goods are left in a heap or in some little-ventilated place, twenty-four hours are often sufficient to start the formation of fungi.

Goods treated with weakened solutions are found to be less liable to mildew than those not so treated. Such treatment is common in the manufacture of some kinds of goods, the acid being carefully washed out of the texture and all remaining traces of it neutralized by soda salts. Washed cloth should not be kept for any length of time upon the bottom of a fulling or a washing machine. Neither should it be hung upon wooden supports that have begun to decay, as such supports are likely to contain the spores of the fungus and infect the goods. Generally speaking, cloth made from badly-washed wool, in all stages of its manufacture, is more liable to mildew than that made from thoroughly-cleaned wool.

Hardly less dangerous than sizing in crude material is soap in fulled cloth. It appears that the decomposition of dyestuff and fiber by the soap is a process differing from the actual formation of mould, as if the alkali had a destroying effect in consequence of the heating. In the case of fulled cloth not yet washed, a few hours' storage only is necessary to produce mould spots of larger size and more injurious character than those liable to appear in the crude cloth. For this reason fulled cloth should at once be placed in the washing machine; if this is not possible, it should be washed in the fulling mill.

In order that the woolen manufacturer may protect himself against damage by mould spots, let him, before anything else, see that the cloth, either in a crude or a fulled condition, does not lie longer than is absolutely necessary. Should a delay occur at any time, let him dry the wet places as soon as possible, and not let them accumulate in a wet condition in warm places, drying chambers, etc. Finally, he should guard them from the direct influence of the sun's rays.

When the fiber has not been attacked, mildew can be washed out with soap and water, but, when this fails, resort must be had to chlorid of lime, peroxid of hydrogen, and other bleaching agents.

An Essential for Making Good Bread.

MR. J. B. ALLFREE, in *American Miller* for December, makes, and plausibly sustains, the statement that the best bread possible can be made only from a flour that has its granules of uniform, or approximately uniform, size. He reasons as follows: "Yeast being a plant of the most extraordinary and rapid growth, rapidly setting up in any mass into which it has been introduced conditions similar to its own, it is evident that the impalpable portion of flour will be acted upon speedily, while only the superficial layers of the larger granules would be affected by the ferment. Where such conditions exist,—that is, where the flour granules vary in size,—the process cannot proceed uniformly. The fine particles cannot wait upon the coarse. They will have passed through the various stages, and too often have reached the acid stage, before the coarser or larger particles will have been more than superficially acted upon. Therefore carbonic acid gas that has been generated by the smaller particles will have been eliminated from the mass, and its usefulness destroyed, while a portion of the nutritive properties will be transformed into this gas and carried away by it. This will materially affect the size of the loaf as well as the flavor and dietetic value of the bread, and, furthermore, from over fermentation, other chemical conditions arise, resulting in discoloration.

"On the other hand, if the flour granules be of even size, this chemical action will be uniform, the entire mass will reach the alcoholic or bread stage at the same time, and, when put into the oven, the heat will stop further fermentation, as well as serving to cook the loaf and further enlarge it by the expansion of the air and the gas contained in it. Thus the nutrient properties are retained, raising the commercial as well as the hygienic value of the bread.

Cost of Haulage on Common Roads.

ENGINEERING NEWS (Dec. 5) prints a statement made by the office of road inquiry in the United States department of agriculture, from which the mathematical and logical conclusion is that the agricultural industry of the United States pays annually about one-third the total value of its products for hauling these products over the common roads to points where they are sold or shipped. The total value of these products was estimated in 1890 at $2,480,170,454, and the total cost of haulage is estimated at $946,414,665. Upon this rather startling statement the following comment is made:

"Certainly, if the figures above given are correct, and if it actually costs a third of the total value of all products of the country's farms and forests to transport them, not to the consumer, but only to the point of shipment by rail or water, the fact is of the greatest economic and industrial importance." This cost, borne wholly by farmers, is double the total earnings of the railways for freights, exclusive of those never carried over common roads, and it largely due to bad roads. Two thirds of it might probably be save by road improvement.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Technical Journals—See Introductory.

*2472. An Engineer's Life in the Tropics, Ill. Charles P, Yeatman (Showing the sanitary dangers and physical discomforts attending the work of foreign engineers in South American countries). Eng Mag-Jan. 2800 w.

2475. Practical Advice for the Direct Photographing of Colors According to the Lippmann Method (Full detailed directions for making solutions, preparing the plates, regulating the exposure; description and illustrations of the apparatus, etc.) Sci Am Sup-Nov. 9. 1300 w.

†2512. Comparison in Practice of the Metric and English Systems of Weights and Measures. Arthur Lagron (An argument in favor of the metric system. The discussion by members brought out the difficulties that must be surmounted in introducing it into general practice in the United States). 10th An Rept of Ill Soc of Eng & Surv. 2200 w.

2575. Methods of Measuring High Temperatures. Ill. (An exhaustive review of the subject, containing information obtained from a considerable variety of sources, and noting the advances in the art of pyrometry up to date, with editorial comments). Eng News-Nov. 14. 7500 w.

2582. Electro-thermal Chemistry of Calcium Carbide (A chemical compound of popular interest, usually described under the name of calcium acetylene. An explanation of recent investigations). W. Elec-Nov. 16. 2200 w.

2594. The Thermophone (Illustrated description of a new instrument for, and method of determining temperatures in distant and inaccessible places). Pro Age-Nov. 15. 900 w.

2597. The Thermophone. George Chandler Whipple (A description and explanation of the action of an instrument invented by Henry E. Warren and George C. Whipple, with some account of its varied uses). Science-Nov. 15. 2000 w.

*2634. Eutropy. R. C. Carpenter (The term is defined and its use as applied to the theory of heat engines is explained. A table of the eutropy of water is appended and the subject is further illustrated by diagrams). Sib Jour En-gng Oct. 3300 w.

*2662. The Work of Technical Societies (Editorial review of the origin, spread, and general results of these societies). Engng–Nov. 8. 2700 w.

2691. The Slide Rule and How to Use it. G. D. Snyder (A very thorough exposition of the principles underlying the construction of this instrument and its use, with examples showing its numerous labor-saving applications in scientific and technical work.) Engng News–Nov. 21. 2900 w.

2723. Mildew (Its origin, growth and trouble to cotton and woolen manufacturers). Bos Jonr of Cm.–Nov. 23 1300 w.

*2725. A Romance of Modern Industry (A extremely interesting story of the development of the aluminum industry, the ruin of an English enterprise based on the Castner process, by the introduction in America of the electrolytic method of producing metallic aluminum, and the recovery of the fortunes of the company by turning to account the knowledge gained in its abandoned aluminum industry in the manufacture, by a new process, of caustic soda and bleaching powder). Ir & Coal Tr Rev–Nov. 15. 1500 w.

*2738. Double Refraction of Electric Rays. Peter Lebedew (Experiments with technical details). Elect'n–Nov. 15. 3500 w.

2780. Meteorology in the University. Cleveland Abbe (An extract from a report presented in 1893 to President Seth Low, of Columbia College, recommending the establishment of courses in meteorology and a meteorological laboratory in connection with the University). Science–Nov. 29. 2800 w.

†2830. The Temperature Variation of the Thermal Conductivities of Marble and Slate. B. O Peirce and R. W. Willson (Account of an investigation, conducted in the Jefferson physical laboratory, at Cambridge, with refined apparatus and methods, which are described and illustrated with diagrams). Am Jour of Sci–Dec. 1900 w.

†2832. On Some Devices for the Separation of Minerals of High Specific Gravity. S. L. Penfield (Illustrated description of apparatus and methods, and account of some experiments in which these were employed). Am Jour of Sci–Dec. 1100 w.

†2833. How to Find the Key Note of Auditoriums. Ephraim Cutter (The principle of air physics which this method is designed to carry out, is that oratorical phonation should be in the key note of the audience, the oripulations of speech being the same as those of song, and the basic vowels of speech and of song being the same. Directions for ascertaining the key of any auditorium are then given, with a number of examples of its application in different buildings). Am Jour of Sci–Dec. 1100 w.

†2851. Prehistoric Engineering at Lake Copais. John Denison Champlin (An antiquarian research of historical interest, but of little practical import. The ground now occupied by the lake is held to have once been cultivated land, fitted for cultivation by artificial drainage, which was probably effected by natural tunnels. These becoming obstructed were probably reopened. Recent discoveries show that an ancient and complete hydraulic system existed for the drainage of the tract). Pop Sci M–Dec. 4000 w.

†2853. Why the Sea Is Salt. G. W. Littlehales (Maintains that the sea was salt from the beginning instead of slowly becoming so by salts carried into it from the main land in imperceptible quantities as has been supposed by some. Gives chemical and geological reasons for this opinion. A theory of the genesis of oceans is also given). Pop Sci M–Dec. 1600 w.

†2877. Technical Notes on the Gramophone. Emile Berliner (This paper is an elaboration of the system of gramophony, as described by Mr. Berliner, in a previous paper read by him before the Franklin Institute, and published in the Journal. It is illustrated by diagrams and is one of the most attractive scientific papers of the month). Jour Fr Inst–Dec. 5000 w.

*2880. Recent Improvements in Lighthouse Illumination. Ill. (Historical account of improvements since 1822). Nature–Nov. 26. 1700 w.

2886. Night Photography by Electric Light. Ill. Joseph F. Mullander and Sidney Sprout (An account of the researches in this field and the highly satisfactory results). Jour of Elec– .Otↄ 300 w3.

2925. Recent Improvements in the Sugar Industry. M. L. Lindet (Reprinted from *Jour of the Soc. of Chem. Ind.* Describes improvements in beet sugar industry, which appear to have extended to nearly every operation comprised in the manufacture). Sci Am Sup–Dec. 7. 2000 w.

2927. The Nitrogen of the Air as a Plant Food. George McGowan (The physical and biological principles whereby some kinds of plants are rendered pre-eminent as absorbers and storers of nitrogen, which, if they are left to decompose in the earth become food for other plants having this power in less degree). Sci Am Sup–Dec. 7. 3200 w.

2941. The Cost of Hauling Freight on Common Roads (Abstract from a Dept. of Agriculture Report, giving the results of the investigations and further information contributed editorially). Eng News–Dec. 5. 2200 w.

*2953. The Superior Bread-Making Qualities of Evenly Granulated Flour. J. B. Allfree (The general principles of bread-making in relation to the quality of flour used in it). Am Miller–Dec. 1500 w.

*2966. The Metre System of Weights and Measures (A deputation representing 46 Chambers of Commerce, waited upon Mr. Balfour, to urge the desirability of adopting the metric system of weights and measures. Abstract of remarks made by the committee and Mr. Balfour's reply). Nature–Nov. 28. 4000 w.

2980. A Plea for Better Protection of Life and Property. Christopher Clarke. Suggestions of plans of protection and prevention resulting from years of study of the subject of reducing loss by fires in buildings). Fire & Water–Dec. 7. 800 w.

*2988. Approximate Calculations. A. H. Barker (Short methods for simple operations to obtain closely approximate results). Prac Eng–Nov. 29. 1500 w.

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

Wilkins and Davison, Engineers, Pittsburgh, Pa., U. S. A.=Engineering Views, being twenty-four elegant plates in half-tone, of bridges, water works, engine houses, and other structures erected from designs of this firm.

Nutting Truck Works, Faribault, Minn., U. S. A.=Catalogue and price list of new and standard styles of platform and handle trucks—2-, 4- and 6-wheeled, for handling goods and materials in factories, warehouses, etc. 22 pp.

Edward Smith & Co., New York, U. S. A.=Pamphlet, entitled "Application of Paints, Varnishes and Enamels for the Protection of Iron and Steel Structures and Hydraulic Work." Contains an interesting essay on this subject, describes the paint made by this firm and presents testimonials confirming its value.

Davis Heater Co., Racine, Wis., U. S. A.=Pamphlet, 16 pp., describing steam and hot water heaters for warming buildings.

Beaman & Smith, Providence, R. I., U. S. A.=Catalogue, D, 63 pp. Illustrating and describing an extensive list of machine tools manufactured by this firm.

Fort Wayne Electric Corporation, Fort Wayne, Ind., U. S. A.=Large and elegant catalogue of electrical machinery and apparatus for light and power. (The Wood Systems) 132 pp.

The Billings & Spencer Co., Hartford, Conn., U. S. A.=Large and elegant catalogue, illustrating and describing electric railway and trolley specialities, commutator segments, machine shop tools, and drop forged goods in variety.

The Long & Allstatter Co., Hamilton, Ohio. U. S. A.=Catalogue No. 18, 88 pp., illustrating and describing an extensive line of punching and shearing machinery. Over 350 sizes and styles, for all kinds of punching and shearing in metal by power, are catalogued.

The Weir Frog Co., Cinncinnati, Ohio, U. S. A.=Catalogue, 273 pp. A list of frogs, switches, crossings and all kinds of regular and intricate track work and material, for steam railways, electric railways, cable roads, horse-car lines, and portable track-work, for mines, contractors, plantations, etc.

The Correspondence School of Technology, Cleveland, Ohio, U. S. A.=Instruction by mail in electrical engineering, steam engineering, bridges, roofs and iron structures, surveying and road construction, mechanical engineering, hydraulic engineering, and advanced mathematics.

Robinson Electric Truck and Supply Co., Boston, Mass., U. S. A.=Illustrates and describes the Robinson radial system of car trucks, with diagrams illustrating the difference in action of this truck from that of other car trucks, testimonials, etc.

W. J. Johnston Co., New York, U. S. A.=Catalogue, 48 pp. Electrical Books.

United States Metallic Packing Company, Philadelphia, U. S. A.=Catalogue and price-list, 26 pp. Stuffing-boxes, locomotive packings, stationary and marine engine packings, metallic packings, lever-lock mechanism, lubricators, oil cups, portable drilling machines, etc.

Bird Paper Manufacturing Co., New York, U. S. A.=Samples, bound in book form, of three grades of water-proof building and insulated paper.

Pen Argyl Iron Works, Pen Argyl, Pa., U. S. A.=Catalogue, 60 pp., 7" × 10". [Describing and illustrating a line of high-grade hoisting machinery for mines, quarries, pile driving, bridge building, and general construction work.]

American Boiler Co., New York and Chicago, U. S. A.=Partial list of users. [Forty-five feet of references, confidently believed to be the largest list of steam and hot-water heater consumers ever printed. The company estimates that the names which appear in these lists are only about one-half the actual number of users of their heaters. The lists are printed in a continuous roll, making a very striking exhibit.]

Dwight Slate Machine Co., Hartford, Conn., U. S. A.=Catalogue, 1895. [Describes and illustrates an extensive line of machine tools.]

The Lidgerwood Manufacturing Company, New York, U. S. A.=Pamphlet (in press) "Travelling Cableways, and Some Other Devices Employed by the Contractors on the Chicago Drainage Canal." [This book will be one of the well-known sketch-book series, same size as the previous issues, containing 72 pages, and 36 full-page illustrations, intended particularly to illustrate the multiplicity of uses to which the Lidgerwood hoisting engine can be applied. The travelling cableways, twenty of which have been sold and used on the Chicago Drainage Canal, occupy the larger part of the book, which may be had, free of cost, on application to the company at 96 Liberty street, New York city.]

A. D. Quint, Hartford, Conn., U. S. A.=Catalogue, 20 pp. Quint's turret drills.

Babcock Printing Press Co., New London, Conn., U. S. A.=Catalogue, 32 pp., describing and illustrating printing presses.

Gesholt Machine Co., Madison, Wis., U. S. A.=Catalogue, 44 pp., illustrating and describing turret lathes, screw machines, monitor, gap and chucking lathes, and universal tool grinders.

Robb Engineering Co., Amherst, N. S.=(a) Pamphlet, 38 pp., illustrating and describing the Robb-Armstrong Engine. (b) Pamphlet 16 pp, illustrating and describing this engine direct connected to dynamo.

American Balance Slide-Valve Co., San Francisco, Cal., U. S. A.=Pamphlet illustrating and describing the "American" balance slide valve.

Prentiss Vise Co., New York, U. S. A.=Catalogue and price list of vises with cuts and descriptions.

Frick Company, Waynesboro, Pa., U. S. A.=Catalogue, 107 pp., describing and illustrating engines, and boilers, including the "Eclipse" Corliss Engine.

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JINGOISM, OR WAR UPON DOMESTIC INDUSTRY.

By Edward Atkinson.

A DEFINITION of Jingoism has often been called for. What better one can be given than the following statement?

It is the expression of aggressive interference in questions with which this country has no direct concern. It is an incitement to violent interference before the facts governing the case are or can be known, and before the respective rights of the parties in contention have been established. It is the promotion of animosity tending to lead to war before any cause has been shown which could justify the officials themselves who may for the time have the power to threaten such a terrible alternative. Jingoism is customarily the resort of weak minds in their effort to attain personal notoriety; but its causes are deep-seated, and it has perverted the minds of men in high position.

It is not the purpose of the writer to deal with the details of the pending contention in regard to the boundary between British Guiana and Venezuela. In the message of the president and the accompanying documents which exposed the credit and the business of this country to a most severe shock it is admitted:

(1) That, if this dispute about the title to a certain area of territory in South America were settled by the parties themselves, either for money or for any other consideration, it would not concern the United States;

(2) In the proposal to appoint a commission it is also admitted that it is necessary to establish the facts and to determine the rights in the case, and that the executive department of our government is not now informed upon the facts, and is therefore without information which would justify any positive action.

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Yet, in spite of this admitted ignorance of the facts necessary to a decision in order to justify any action whatever, the country has been suddenly brought to a great danger by threat of interference, by force or war, in this petty contention. Such a war between the two great branches of the English-speaking people would be dishonor and disgrace to both. Upon them now rests the defence of personal liberty, of the equal rights of mankind, and of equal opportunities for men to establish their own institutions and their own forms of constitutional government. These were the purposes to which the Monroe doctrine was directed with the assent of Great Britain. A war between the English-speaking people would give the opportunity to dynastic powers to attack the very principles which they have always regarded with dread, but which they have not dared to attack so long as their conservators were united in their support. Such a war would be a war upon humanity, reversing the progress of civilization,—a betrayal of trust by the English-speaking people who have carried the principle of personal liberty over great continents and who are charged with the duty of maintaining it.

But whether or not the two propositions which have been submitted are well grounded ; whether or not the conditions may be somewhat different from those which now appear to be true, so far as they are disclosed by official documents,—can any one conceive of such incapacity on the part of the officials either of this country or of Great Britain as to render a war even remotely possible upon such a petty issue? What wonder that after the first vacant ravings of the jingo faction had become exhausted the masses of this country should have aroused themselves from a state of shuddering horror that such a crime against the principle of personal liberty could have become possible ! They have spoken, and they are now exerting their commanding power in order to remove the causes of the danger to which they have been so ruthlessly exposed.

In the previous lesser contest in which all citizens of repute, without distinction of party, were engaged for the suppression of the jingo faction, before this great danger had aroused the country, it was sometimes urged, by men who now occupy, without filling, a few places of public trust, that the honor of the country should not be weighed against mere dollars and cents. That might be admitted ; but what we have now to do is to compute the cost of the possible dishonor of the country.

How necessary it may be to count this cost and to provide for it is witnessed by the second message of the president, following immediately after the first. This first message brought to utter confusion all previous plans for remedying the evils of bad money and bad methods of taxation. In this second message the president urges congress to provide the means for meeting the new dangers, and to enact measures for diminishing the evil influence of the war upon domestic industry which is the necessary result of Jingoism, that evil influence exerting itself in greater or less measure according to the source from which it emanates.

A great wrong has been committed, which it is too late to remedy; but yet greater wrong may still be prevented. The paralysis of industry which had been brought upon us by the advocates of the free coinage of silver had been surmounted. The necessity for maintaining the lawful unit of value of the nation had been admitted and accepted without further contest. The danger of the forced loan for the continued purchase of silver bullion had been removed by a repeal of the Sherman act. The deficiency of revenue which originated in the repeal of the revenue duties on sugar in the act of 1890 had been nearly overcome. A revenue equal to the expenditures in the next calendar year had become assured, provided normal conditions had been maintained. Finally, the production of iron, which is the surest standard by which to measure prospective progress and which is the indicator of constructive energy and of renewed prosperity, had reached a magnitude never known before. All the physical and material conditions of the country were ripe for activity and welfare.

All these favorable anticipations were suddenly changed to conditions of danger, distrust, and discredit.

This wrong lies at the door of those who would promote war without the justification of self-defence. Hence arises the necessity for counting the cost and declaring the price which we have paid, or must pay if a jingo policy should become the practice of this country.

We will now deal with facts which cannot be gainsaid. Before doing so, let it be remembered that the subtle influence of Jingoism has long been in action. Almost without knowing how the revenue of the country was being expended, we one day learned that two naval vessels had been provided at a cost of many million dollars, which are known as "commerce destroyers." These ships are useless for defence, and are useless for attack upon any vessels except those which bear the surplus products, mostly from our farms, to the use and benefit of our principal customers who pay us for them. These vessels are to be devoted, if used at all, to the plundering of private property, which would disgrace an officer of the army upon land, but which will be imposed as a duty upon the officers of the navy. Yet such acts of war would be but a part of the war upon our own domestic industry which is the necessary result of the jingo policy. This proposed attack, which would be first directed upon the domestic industry of the farmer, is indirectly as serious a war upon our domestic manufacturers, whose great market is among the farmers. If the farmers cannot sell their crops at a profit, they cannot buy the goods made in our factories or the wares made in our workshops. *The profit depends upon an open export demand for their surplus products.*

The proportion of persons occupied in agriculture in 1890 was rather less than in 1880, but it still constituted a fraction under forty per cent. of all who are occupied in gainful pursuits. The same error undoubtedly existed in the last census that Commissioner Walker pointed out in the census of 1880. A large number of persons who are classified as laborers under the head of personal service are occupied wholly or during a part of each year in agriculture. There is also a very large class listed in the census as occupied in manufacturing, whose work consists in converting the crude products of the farm into the secondary form in which they can be moved long distances or exported. This transfer by occupation can only be estimated, but no one who is accustomed to dealing with statistics can fail to reach the conclusion that substantially one-half of the whole number of persons who were occupied for gain in 1890, numbering a little under 23,000,000, or one in each 2.75 of our population, depended upon a market for the products of the farm, the dairy, the meat-packing and -canning industry, the milling of grain, and upon the various branches of converting crude farm products into the secondary form for sale as agricultural products. Upon the prosperity of this great productive class of 11,500,000 rests that of the manufacturers, the merchants, the traders, the railways, and the inland water ways of the country.

The prosperity of all who deal directly or indirectly with farm products depends upon finding an open market for the sale of the excess of the food and fibres which could not be consumed in this country. That principal market is found in the United Kingdom of Great Britain, Germany, France, Belgium, and the Netherlands, and these countries are the only ones whose ocean-borne commerce is of any considerable importance,—the only ones upon whose traffic our basely-minded commerce destroyers could work the malignant destruction. Witness the facts.

In the ten years from 1885 to 1894 inclusive the exports of the domestic products of this country possessed a value of a little under eight billions of dollars ($7,943,346,945). Of this sum a little under six billions ($5,886,829,343) consisted of the products of agriculture. In the same period the imports for which those exports were exchanged amounted to a little under seven and a half billions ($7,348,396,601). The difference, about six hundred millions in gold ($600,000,000), was placed at our credit in gold coin in the banks of Europe.

Three-fourths of our exports, nearly six billions in value ($5,869,669,581), consisting of more than three-fourths of the products of agriculture, were sold to Great Britain, France, Germany, Belgium, and Holland. The imports from these countries were valued at a little under three and a half billions ($3,344,541,518), constituting but forty-five per cent. of our imports. The difference, amounting to two and a half billions ($2,525,128,063), was passed to our credit in gold coin in European banks, subject to our drafts. We drew against that deposit for our purchases of tea, coffee, sugar, dye stuffs, and other products of tropical and semi tropical countries, which are mainly silver-standard countries, for about three-fourths of this sum, and, so far as gold possessed an increasing power of purchase as compared to silver, we gained that benefit in the increased quantity of goods thus secured.

The exact facts of our export and import traffic with these specific countries will be found below:

	Exports.	Imports.
Holland	251,467,828	115,880,861
Belgium	275,801,834	95,921,479
France	528,776,130	675,934,578
Germany	753,488,170	817,868,418
	1,809,533,962	1,705,605,336
Great Britain	4,060,135,619	1,638,936,182
	5,869,669,581	3,344,541,518
Balance credit in gold coin		2,525,128,063
	$5,868,669,581	$5,869,669,581

It will be remarked that our traffic with Holland, Belgium, France, and Germany placed at our credit a fraction over one hundred million dollars ($100,000,000), while our traffic with Great Britain, against which the brutal fulminations of the jingoists are chiefly directed, placed at our credit over twenty-four hundred million dollars ($2,400,000,000).

But even this table does not show the complete interdependence of the English-speaking people or the mutual service which they render to each other.

Our exports to the British colonies and their dependencies—Australia, to which we export twice what we import; Canada, to which we export more than we import; India, Hongkong, Africa, Honduras, and Guiana—in the ten years 1885 to 1894 inclusive exceeded seven hundred million dollars ($700,000,000). Our imports from all these colonies—the excess being over exports in the last six named—came to a fraction under eight hundred and thirty million dollars ($830,000,000).

The value of our commerce with the machine-using nations of the world and the British colonies, as compared to all others, is as follows :

	Per cent.	Exports to.	Imports from.	Per cent.
Great Britain and her colonies..............	60.	4,765,830,100	2,468,475,746	33.60
Holland, Belgium, France, and Germany........	22.79	1,809,533,962	1,705,605,336	23.22
	82.79	6,575,364,062	4,174,081,082	56.82
All other countries......	17.21	1,367,982,873	3,172,315,519	43.18
	100.		7,346,396,601	100.
Merchandise balance....			596,950,334	
		$7,943,346,935	$7,943,346,935	

These figures are very significant. Sixty per cent. of our exports, consisting in by far the largest measure of farm products, are bought of us on a gold basis by Great Britain and her colonies. A fraction under twenty-three per cent., also consisting in largest measure of farm products, are bought by France, Germany, Belgium, and Holland. Seventeen per cent., consisting in much larger measure of manufactured goods than of farm products, are bought by all other countries, and that branch of our traffic is very rapidly increasing, since the virtual control of the iron and steel manufacture has passed to this country.

It may be remarked that, with the development during the last ten years of the "basic" steel, so-called, and the increase in its production in Germany, coupled with the conditions under which this country has assumed the paramount position in the world in the production of iron and steel, the exports of manufactures from Germany and this country have rapidly increased. In point of fact, the control of iron and steel, with an excess of fuel, is bringing this country rapidly to the leading position in supplying machine-made fabrics to all nations.

In respect to our imports, a fraction under thirty-four per cent. are supplied by Great Britain and her colonies, of whom we are the largest single customer, and a fraction over twenty-three per cent. by France, Germany, Holland, and Belgium,—making in all fifty-seven per cent. of the whole, the remaining forty-three per cent. being supplied by other countries. These imports consisted chiefly of tea, coffee, sugar, and other tropical and semi-tropical products. Without going into minute details, it appears, therefore, that ninety per cent. of our entire exports are bought by the gold-standard countries of the world, while fifty per cent. of our imports come from silver-standard countries, or from States which are yet worse afflicted with a depreciated paper currency. The balance of the trade with the gold-standard countries amounts to twenty-five hundred million dollars ($2,500,000,000). It thus appears that an average of two hundred and fifty million dollars ($250,000,000) a year has been placed at our credit each year for ten years in pounds sterling in the banking centers of the world, mainly in London. Yet in that ten years we have been tampering with our standard of value ; we have been exposed to the danger of the silver craze and to the debasement of our standard of value to the fluctuating and lessening unit of silver ; and, by the way of a combination of jingoists, Populists, and the advocates of taxes upon imports up to the prohibitory point for the purpose of isolating this country, we have been brought into our present condition of distress, discredit, and dishonor.*

These figures of our foreign commerce, upon which the prosperity of our domestic industry rests, bring one fact into most conspicuous notice.

The English-speaking people are the conservators of personal liberty,—of equal rights and of equal opportunity. These foundations of moral and material welfare have been established in this country as well as in Great Britain and her colonies upon the basis of the common law under constitutional forms of government. Wherever the English-speaking people govern, or where they control the government and protect the people of many races, a just administration of the law is assured, and every effort is made to promote the common welfare of all alike. It is nearly a century since Great Britain gave up the effort to control the colonies of America, of Ireland, and of her dependencies in many parts of the world under the former medieval idea that all such possessions should be governed for the sole purpose of promoting the welfare of the British islands ; yet the animosity which was rightly caused by those efforts has been continued and has been promoted by the jingo element in this country for two generations since the cause was removed. The English-speaking people of this country are called upon even now to meet the same difficulties in dealing with different races of men and with varying conditions growing out of the former state of society that are met by the people of Great Britain in India and elsewhere ; yet slowly and surely the right method is evolved, material and political progress are assured, and the credit of the English-speaking nations and States, on which moral as well as material welfare rests, is being finally and firmly established.

No surer evidence of these facts could be cited than the foregoing statistics of commerce, proving the interdependence of the respective countries and measuring the mutual service which they render to each other in due proportion to their control of modern invention and mechanism,—in due proportion to the justice of their rule,—in due proportion to the credit of their monetary system,—in due proportion to their respect for law,—and in due proportion to their freedom from dynastic oppression and from centralized methods of government,—thus giving a lesson in statistics of the utmost value. The figures appear to measure merely dollars and cents, but to him who can read between the lines they convey evidence of progress in material, mental, and political welfare alike.

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* See *North American Review* for February, 1896, on "Future Production of Gold."

It is not often justifiable or judicious to use severe terms in public discussion, but, when the occasion comes, he who spares an enemy deserves himself defeat. The jingoists of our time are public enemies, who promote unreasoning aggression and violence in ignorance of the facts that in our intercourse with other nations they would bring upon us what one of the greatest generals of the civil war by which the jingoists of slavery were quelled rightly named "The Hell of War" without the justification of self-defence.

This treatise has been completed on Christmas Day. May God grant that, when it is printed, peace may have been assured, and that, by the united force of public opinion among the masses of the English-speaking people, the jingo classes will have been compelled to retire from public view in contempt.

> "Of what avail are plough and sail,
> Or land, or life—if freedom fail?"

Even while the foregoing portion of this treatise was being put in type there has been a profound and wide-spread movement in this country on the part of masters of international law, of merchants, of manufacturers and bankers, of the clergy, and of the trades unions and other labor organizations, forbidding war among the English-speaking people, and demanding that the vague terms of the Monroe doctrine shall be put into a definite form by the representatives of Great Britain and the United States, with whom it jointly originated. The moral sense of the nation has been aroused, and this decree has been uttered in terms that no congress can disregard and no executive can resist. There is every reason to believe that corresponding action has been taken in Great Britain. The time is, therefore, at hand when the masses of the English-speaking people, coöperating through their appointed agents, may suppress the jingo classes in both countries, and may bring moral forces into action which will forever assure peace, order, and industry among them. Their material interests as well as their moral and political welfare are at stake. The future prosperity of the western farmer, of the southern cotton-grower, and of the eastern manufacturer and mechanic alike depend upon present action.

Is there not something grotesque in the total inconsistency between the precepts which have been so long put before us and our present practice in our relations with Great Britain? In practice we spend huge sums of money to improve our railways and to enlarge our canals. We ask for great appropriations to improve our rivers and harbors. Every city upon our coast is trying to devise methods for enlarging its docks. All this work is done to promote and secure a foreign market for the excess of our farm products, and to open the way for commerce with other nations, of which sixty per cent. is with British possessions. We are striving to do away with every physical obstruction that can impede the exchange of products, in order to secure our part of the mutual benefit of the nations which share therein.

The greater part of this commerce consists in supplying the machine-using nations, with whom we compete in manufacturing, with food, metal, timber, and fibres, because we find that our commerce with such nations is greater than with all the rest of the world, and that the benefit corresponds. Having exhausted all our efforts on these lines, we are then assured by the jingoist that our chief customers are waging an aggressive war on our domestic industry. We are told that the maintenance of a single, true, just monetary standard is adverse to our "great silver interests," and therefore detrimental to this country, the average annual product of this "great silver interest" being about a third of the value of the hens' eggs annually produced in our barnyards.

We are told that the honor of this country depends upon defending the title claimed by a South American republic to a piece of malarious tropical land in South America, in disregard of the fact that the system of voting in that republic is usually conducted with bullets, and not with ballots. We are threatened with war with our own kindred beyond the sea in documents uttered by the government officers, in which their own ignorance of the facts of the case is admitted by asking for a commission to determine the facts. This case has been most fitly described by one of the ablest members of the bar as being characterized by "bad law, bad morals, and bad manners."

Yet perhaps no surer method could have been devised to bring about a final removal of all the prejudices which exist among the masses of the English speaking people at the present time than this effort of the jingo classes to promote continued animosity. The recent shock to the public conscience will end in a concentration of the moral forces and the material interests of the people of the United States and of Great

Britain for the purpose of assuring permanent peace and order among them. Already a definite movement is well under way for the organization of an international union whose objects may be thus briefly summarized:

(1) Any international question of title to land shall be adjudicated by judges learned in international law,—precisely as all other questions of land title are adjudicated.

(2) Any question of international damages shall be referred to arbitration.

(3) Private property upon the seas, other than contraband of war, shall be exempt from seizure.

(4) Privateering shall be abolished.

(5) No city adjacent to a fortified harbor, which is not itself made part of the harbor defence and defended by arms, shall be bombarded.

(6) Measures shall be taken to maintain the rights of lesser States.

(7) Measures shall be taken to sustain organized governments by mutual agreement in isolated places, like the Sandwich Islands and Samoa, and to neutralize them as free ports.

(8) General measures shall be defined for the maintenance of peace.

(9) Measures shall be taken for abating the evils of war, and to bring into this Union for Peace as many other States and nations as may be induced to join it, especially in South and Central America, to the end that the common purpose of England and the United States, which has been partially formulated under the name of the Monroe doctrine, may be defined and safely and surely applied.

Many improvements may be suggested for such a declaration of the present purpose of the masses of the people of this country and of Great Britain, and in the progress of their discussion a way will surely be found to give them effect.

TRADE AND INDUSTRY OF SOUTH AMERICA.

By Emilio M. Amores.

THE sixteen republics south of the United States, which include Mexico and the countries of Central America, have a population of over fifty millions of progressive people inhabiting a territory of 8,500,000 square miles extending from Rio Grande to Patagonia and endowed by nature with resources and wealth of surpassing magnitude.

The government and institutions of these countries are very similar to those of the United States. In every one of the countries of South America, ever since their establishment, there has always been a strong leaning, both on the part of the governments and the people, toward the United States, the great republic in the northern half of the continent, after whose model they are patterned. They desire a more free and intimate intercourse with us; yet the volume of our commerce with Latin America is but a shadow compared with what it might be if only a practical effort were made to supply its markets. The geographical position of the South American countries, Cuba, and the rest of the West Indies, make them naturally the first foreign markets for American manufactured products. They naturally look up to this great and enterprising republic as the purveyor of those useful articles which are of prime necessity in every civilized community. In the United States everything that South American nations require can be manufactured, in factories already established, as well and as economically as anywhere in the world. Yet we enjoy but a small percentage of that profitable trade. The people do not use our language, but this is no obstacle; the country supplying the greater part of the wants of that market uses the English language, and the country of least importance in that market is Spain, the mother-country of the South Americans.

In 1860 the trade of the United States, Great Britain, and France, with Mexico, Central and South America, and the West Indies, stood about as follows: the southern countries imported from the three manufacturing nations mentioned merchandise valued at $203,283,201, and exported to the United States, England, and France merchandise valued at $215,985,435. Of the imports there were taken from the United States $44,978,676; from France, $70,319,822; from England, $87,984,703. Of the exports the United States took $79,109,-332; France, $35,156,730; Great Britain, $101,719,373.

In twenty-nine years, or from 1860 to 1889, our imports from

South American countries have increased $126,275,057, or, roughly, 150 per cent. During this period the imports of Great Britain from South America have decreased $12,234,865, or about 12 per cent. On the other hand, the exports of manufactured goods from Great Britain to South America have increased in value over $89,000,000, or over 100 per cent. The value of the exports of the United States to Latin America has likewise doubled, but our export trade is not at all in proportion to our imports from the south. The exports of South America have increased, in the twenty-nine years since 1860, 38 per cent.; the imports, 85 per cent. The commerce of the southern continent rapidly increases with every year, and its possibilities for even the very near future, owing to the great natural resources and the enormous undeveloped mineral wealth of the country, can be but faintly surmised. Greatest of all are the possibilities for American merchants and manufacturers.

The compilation on the next page may be of interest, giving the population according to the last census or estimate. The figures in the year column apply to the commerce of the countries.

A view of the several republics whose territory, resources, and population are greatest and with which the United States have already a considerable trade on a sound basis will give a better idea of the markets and possibilities as a whole.

Brazil, the largest of the southern republics, occupies nearly half of the continent of South America, and claims to have more navigable rivers than any other country in the world. It is situated mainly in the torrid zone, and its climate is generally agreeable. The population is increasing rapidly from immigration. Rio de Janeiro, the chief city, has a population, according to the last municipal census, of nearly 1,000,000 inhabitants. Bahia has 165,000; Pernambuco, 130,000; and there are over fifty cities of 5,000 inhabitants or more. The Roman Catholic church has probably less sway in Brazil than in any other part of Latin America; absolute equality prevails in religion, and education is making rapid advances among the people. The general government maintains a school of mines and a polytechnic school.

Brazil is naturally an agricultural country, and only a small part of its soil has been brought under cultivation. The land is rich in coffee and sugar. The lands suited to the production of the latter article are practically unlimited in extent; the cotton yield is abundant, and the cultivation of the manioc and cocoa is increasing. Rubber is the principal product of the Amazon valley, 33,000,000 pounds having been exported from Pará in 1888.

The forests and mines are of great value, but comparatively little has been done for their development. Iron abounds, as well

			Total Foreign Commerce the year mentioned.			Value of Commerce with the U. S.	Value of Commerce with the U. S.
	Area in Square Miles.	Population, latest estimates.		Imports, dollars.	Exports, dollars.	Imports from U.S. dollars.	Exports to U. S. dollars.
Mexico...........	767,237	11,632,924	1888–89	40,024 894	60,150,423	13.212 773	23.319.263
Central America							
Guatemala.....	63,397	1,471,025	1890	7,639,833	14.401,534	1,161,159	2 605.273
Honduras........	47,090	450 000	1889–90	1.531,349	2,667.008	1,634,474	860.212
Nicaragua.......	49,500	315,000	1889–90	3,327,006	2,746,794	1,183,858	1.658.400
Salvador.........	7,256	800,000	1890	2,401,314	7.578,734	815,329	1 388 560
Costa Rica.......	23,000	243.205	1891	8.351.029	9.664 607	1,001,104	1.023.983
Brit. Honduras..	7,562	31,471	1890	1,829,480	1,866,099	365,897	206.484
Total Central America......	197,774	3 310,701		25,080,011	38.924,769	6.161.821	7.742,912
South America ..							
Colombia.......	504,773	4.000,000	1890	13,345,792	20.457,855	2,739,347	3.809,953
Venezuela........	599,538	2,500,000	1889–90	16,137,581	19,477,048	4 102.306	12,570.317
Brazil.............	3,251,829	14,000,000	1890	142,514,600	173,530 812	10,848,271	60 620 047
Argentine........	1,125,156	4,000 000	1891	67,100,000	96,700,000	11.230 022	5.748,806
Bolivia...........	784,554	2.333.350	1887	5,720,000	12,260,000	6.661	281
Chili..............	290,828	3,267.441	1889	65,092,013	65,963,100	5 526.696	2 920.386
Ecuador........	248,350	1,272 065	1890	10,010,352	9,761,634	750 972	331.847
Paraguay	88,807	600,000	1890	2,725,612	2,901,589		546.230
Peru	483,747	6,000 000	1887	8.658,531	8,872,287	1.166,765	2,736.678
Uruguay.........	72,172	750 000	1890	32 364.627	29.085,519	3,566,701	3,561 150
British Guiana...	109,000	288,328	1891	8,197.294	12,156,261	2 072,392	562,642
Dutch Guiana....	46,060	70 951	1889	1,967.129	1,415 791	254,384	8,680
French Guiana..	30,463	26,605	1889	1.727.543	824,496	142,162	
Continent South America,....	7,635,282	36,608,840		375.065 074	453 406 390	42,396,679	93,317,251
Mex., Central & South America	8,600,293	51.552 465		430,169,979	553,489 582	68,781,173	114,379 426
Cuba.............	45,883	1,631,687	1891	52,954.582	99 407,902	12,038,046	56,336,064
Puerto Rico.. ..	3,550	813.937	1890	18.230.384	10,710.519	2,232 637	4,865,970
Haiti.............	10,204	960,000	1890–91	10,060.979	14.165,779	4.051.981	3,737.849
Santo Domingo..	18,045	610,000	1890	2,406,769	3.895.109	1 150.294	1.743,277
British W. Indies	18,428	1,373,218	1890	32,405 328	31,053.849	8,362,395	15 237,984
Danish W. Indies	118	36 450		no data	no data	752 946	674 939
Dutch W. Indies.	403	45,799	1889	1,383.486	269,168	728,097	228.773
French W. Indies	965	341,762		9,892,954	9,380.343	1.816 989	180 341
Total W. Indies	97,596	5,812,853		127.334 483	168,882,669	31,133,385	93.005 197
Grand Total...	8,677,889	57,365,308		557,504,462	722,364,251	99,814,558	207,384,623

as copper, manganese, and lead. There are about 17,000,000 head of cattle. In 1888 there were 90 cotton mills running, and the number was increasing. In 1889 there were about 6,500 miles of railway, and 5,000 miles projected. The telegraph system is under government control, and in 1890 there were 12,467 miles of wire. Brazil has telegraphic communication with the United States by three lines: with Montevideo, thence across to the Pacific coast, and thence by the Isthmus to Galveston; by the Western and Brazilian cable to Europe, and thence to New York; by the French cable, *via* West Indies, to Florida.

The commerce of Brazil is principally with Great Britain, France, and the United States, and the principal articles of import are cotton goods, wines and spirits, preserved meats and fish, woolen goods, machinery and manufactures of iron and steel, coal, and manufactures of leather. The exports are principally coffee, hides, tobacco, gold coin and bullion, sugar, diamonds, rubber, cocoa, and rosewood. How small is the share of trade falling to the United States from South America may be seen from the figures relating to the commerce of Brazil in 1890. In that year Brazil imported manufactured articles from Great Britain to the value of $36,297,413 ; from France, $15,635,066 ; and from the United States, $11,902,496. On the other hand, the United States took of Brazil's exports $59,-318,756 ; France, $24,215,788 ; and Great Britain, $21,172,560. Great Britain sent to Brazil in 1890 : cottons, $14,200,000 ; wrought and unwrought iron, $5,100,000 ; machinery, $3,200,000 ; woolens, $1,662,000 ; leather, $1,262,000. France sent : manufactures of leather, $1,190,420 (a falling off of over one half from the three years preceding) ; woolens, $1,105,021 ; cottons, $834,440.

In many quarters at the present time Venezuela is regarded as "an insignificant South American country !" "What is it?" "Of what interest is it to us?"

Venezuela is three times the size of France and of Germany, five times the size of Italy, and, larger than any of the European nations, excepting Russia. There are only two seasons in Venezuela, —summer and winter. The first is dry, and the latter rainy ; but the trees retain their verdure and produce the entire year, as if it were perpetual spring. The climate is varied. On the coast it is hot, but there are never-failing sea breezes, and on the highlands it is cool and delightful ; and there are localities where the mountains are perpetually covered with snow. Although Venezuela is situated in the tropic zone, the temperature does not rise as high as in the corresponding latitudes of Africa. The average heat reaches 80° on the coasts, and the highest temperature felt on the highlands is 71°.

It has a coast line of 1,876 miles, indented by five gulfs, and has fifty inlets and thirty-two ports, besides numerous anchorages. It is bounded on the north by the Caribbean sea and the Atlantic ocean ; on the south by the republic of Brazil, and territory in dispute between Colombia, Ecuador, and Peru ; on the west by Colombia ; and on the east by British Guiana.

Its population is small. The country is traversed by 1,047 rivers, the longest of all being the Orinoco, one of the greatest in the world. Its length is 1,475 miles, almost entirely navigable, and in some places it is 12 miles wide. Its narrowest part is in front of

Bolivar City, where it measures 3,000 feet,—one fourth its average width. The Orinoco has 436 tributaries, rendering navigation to the neighboring republic of Colombia easy; and the branch called the Casiquiare unites it with the River Negro, a great tributary to the Amazon, so that from the mouth of the Orinoco on the Atlantic there is established the extensive water communication which crosses Venezuela, Colombia, Ecuador, Bolivia, and Peru, and which reaches as far as Brazil.

As far as natural resources go, Venezuela is one of the richest of the South American republics, for, although its territory is crossed by three mountain systems, their configuration is such that communication between the plains and valleys is very easy. The greatest wealth is agricultural. The two chief products are coffee and cocoa. Besides these, there are sugar cane, bananas, cotton, indigo, cocoanuts, Indian corn and rice, wheat, barley, etc.

The wooded belt is situated near the Orinoco and contains very rich gold mines. In this belt thrive without cultivation caoutchouc, sarsaparilla, divi-divi, tonka bean, and copaiba. Nature has been lavish in her endowments. In addition to the almost endless variety of rare and precious woods, cereals, and fruits, the country is extremely rich in valuable mines yet undeveloped and open for investments.

Venezuela has largely increased its commerce with the United States during the last decade. In 1880 the exports to this country amounted to $6,040,000, and the imports from this country amounted to $2,270,000. In 1889 the exports to the United States amounted to more than $10,000,000, and the imports to $5,000,000. This is more than Venezuela annually sells to and buys from Europe.

The articles principally in demand in Venezuela are breadstuffs, carriages, carts and cars, coal, cottons, earthen, china and glass ware, fancy articles, manufactures of flax and hemp, gunpowder and explosives, iron and steel manufactures, leather goods, manufactures of wood and wool, paper and stationery, meat, and dairy products. Foreigners are treated well, Americans being especially welcome. The population is increasing rapidly, and there is no country in South America more desirous of extending its relations with the United States than this free republic, with its vast undeveloped resources.

In the Argentine Republic the population is rapidly increasing, owing to immigration. The capital, Buenos Ayres, had a population of 177,790 in 1869, 295,000 in 1882, and 538,385, including suburbs, in November, 1889.

The country extends from latitude 21° to 55° south, a distance of 2,400 miles, and its average breadth is 700 miles. The climate is temperate; we might say that it occupies a place on the southern continent corresponding in climate to that of the United States in the northern. The soil is fertile, valuable forests lie along the river banks, and millions of sheep and cattle roam over the plains. Agriculture has made rapid advancements, and is now one of the greatest sources of the country's wealth. In 1889 the land under cultivation had grown from 825,492 acres in 1875 to 5,899,859 acres, and this is estimated at not more than one per cent. of the total area of the country.

The principal products are wool, hides, skins, wheat, maize, hay, linseed, flour, jerked beef, bran, bones and bone ash, frozen sheep carcasses, hair, sugar, wine, grease, and tallow. Cattle- and sheep-raising is the most important industry, and animal products constitute the chief articles of export.

As in Brazil, some advance has been made in the direction of manufacturing, particularly in textiles, and only a few years ago a well-equipped knitting factory was established in Buenos Ayres.

Mining is an important industry, silver, copper, tin, bismuth, and, in small quantities, bromid of lime being found.

There were 7,676 miles of railway in 1892, connecting the principal towns with the capital. There were, in addition, 10,285 miles under survey or projected. In 1892 there were 70,415 miles of telegraph.

The commerce is chiefly with Great Britain, France, and the United States. In 1890 the Argentine exported to Great Britain articles valued at $20,097,681 and imported from that country merchandise valued at $40,000,000. Exported to France, $41,426,774; imported from, $19,968,408; exported to the United States, $5,401,697; imported from, $8,322,627.

Chili, extending 2,600 miles along the Pacific coast, is divided into four well-marked belts, mineral, agricultural, forestry, and fishery. In the first are extensive guano deposits on the coasts, and rich nitrate fields in the center; borax and iodine are also found. In both the first and second belts there are many rich mines of gold, silver, and copper. Other mineral productions of Chili are mercury, iron, zinc, manganese, coal, nickel, antimony, arsenic, bismuth, sulphur, and cobalt. An idea of its commerce may be had from a glance at Tables 2 and 3.

What has been said of the foregoing countries may be repeated of Peru and the United States of Colombia, as far as abundant and various yield of the soil and extent of mineral resources are concerned. And indeed, for that matter, the remaining countries of South America—Paraguay, Uruguay, Bolivia, Ecuador, and the republics of Cen-

PRINCIPAL DESTINATION OF THE EXPORTS OF LATIN AMERICA.

(From Bureau of Statistics, Report of Treasury Department.)

Countries from which imported.	Imports into—in dollars.				Total, including Spain, Italy, Belgium.
	United States	Great Britain	France	Germany	
Mexico..........	23,319,263	2,267,759	1,655,389	2,569,686	29,956,695
Central America.	7,742,912	7,048,763	1,177,142	3,914,148	21,345,119
Cuba............	56,336,064	508,486	3,668,016	3,869,404	74,284,932
Puerto Rico	4,865,970				4,865,970
West Indies.	21,803,163	11,049,256	21,172,100	6,289,150	61,488,026
South America :					
Guianas....	4,132,472	6,130,374			10,312,987
Colombia........	3,809,953	1,193,704	4.564,400	1,193,570	
Venezuela........	12,470.317	1,385,327	6,821,254	688,296	
Brazil.... .-.....	60,620,047	24,676,211	26,179,203	29,164.996	
Uruguay....	2,736,678	2,192,509	7,825,047	933,436	
Paraguay........				28 560	
Argentine	5,748,806	9,811,749	42,603,067	20.407,310	374,267,306
Chili............	2,920,386	15,887,044	1,614,287	14,620,816	
Bolivia......	281		508,409	574,532	
Peru............	331,847	6,297,136	8,670,831	1,593,886	
Ecuador.........	546,230	352,480	556,542	665,924	
Falkland Islands		693,710			
Total..........	207,384,389	89,484,508	127,015,687	86,513,714	576,521,037

PRINCIPAL SOURCES OF IMPORTS OF LATIN AMERICA.

Countries from which exported.	Exports from—in dollars.				Total, including Spain, Italy, and Belgium.
	United States	Great Britain	France	Germany	
Mexico..........	13,212,773	7,889,112	10,769,400	3,462,424	37,564,089
Central America.	4.795 924	5,085,011	308,800	1,739,304	14,316,574
Cuba............					52,627.957
and Puerto Rico.	14,270,683	13,466,360	2,296,700	1,659,336	42,401,827
West Indies	16,862,684	15,100,013	7,777,900	1,314,474	
South America..					8,751,547
Guianas	2 468,938	4,775,983	1,505,400		
Colombia........	2,729,347	5,974,116	8,260,400	909,874	
Venezuela........	4,102,306	3.905,751	1,891,400	2,194,598	
Brazil............	10,848,271	32,840,573	18,952,600	13,477,230	
Uruguay.........	3.566,701	12,028,615	8,878,000	3,312,484	
Paraguay.........				43,554	350,143,171
Argentine	11,230,022	53,033,608	43,116,200	14,851,676	
Chili............	5,526,696	15,718,615	3,821,400	6.995,534	
Bolivia......	6,661		57,900	241,808	
Peru............	1,166,765	5,225,108	1,814.200	1,631,014	
Ecuador.........	750,972	1,351,919	501,800	414.596	
Falkland Islands		185,287			
Total..........	90,804,640	177,241,778	109,952,100	52,237,906	505,868,165

tral America—are all rich fields, open and waiting for the enterprise of American merchants and the implements and articles of American manufacture, and promise abundant return for the investment of American capital. The mining interests in every one of the States south of us offer the greatest of opportunities to American capital, genius, and skill.

In Ecuador there is a good field for the lucrative employment of capital in mining, but, as the Bureau of American Republics reported in one of its bulletins, "mining is in a very backward condition, only a few mines being worked by an English gold mining company."

Mexico has been lavishly endowed by nature with mineral resources. For nearly four hundred years mining has been carried on there, and in all this time fabulous quantities of precious metals have been extracted, but by far the greater part of her mineral wealth yet awaits enterprising and skilful engineers. At the beginning of this century Humboldt estimated the number of mines in Mexico at 3,000. A decade ago there were hardly as many being worked; but, since the extension of the railroad systems, many more have made their appearance, and the value of their products has greatly increased. Mining has made much greater progress in Mexico than in any of the other Latin-American countries. One reason for this, of course, is that the population of the country is so much greater, and the means of transportation and communication with investing countries are more nearly adequate. The new mining laws that went into effect in 1887 looked to the encouragement of coal, mercury, and iron mining, which had been, and are still, neglected.

In an interesting and complete hand-book on Mexico, issued by the Bureau of American Republics, there is the following on the law of June 7, 1887: "All coal, iron, and quicksilver mines are exempted for fifty years from all federal, State, or municipal taxes (excepting the stamp tax). Iron of Mexican origin in bars, ingots, rails, etc., enjoys the same privilege. All mines other than these mentioned are subject to but one tax, which cannot exceed two per cent. of the value of the annual product. The free circulation of gold and silver, in bars or coined, and, in general, of all the products of mines, can not be impeded by any tax whatever. Mercury is exempted from all tax The tax on reductive works cannot exceed one-fifth of one per cent. of the value of the works. The law also prohibits the State from imposing any tax whatever upon mines, their machinery, products, the capital invested in them, the declarations or denouncements, or any other acts necessary to the acquiring of a mine."

From that time up to a few years ago, it is estimated, over $30,000,000 was invested in mining properties, and, in seventeen months, from April, 1887, 2,077 mines and 33 reduction works were recorded. But the condition of mining in Mexico is more generally known than are the immense possibilities in the other countries of South America, where enterprise and capital have been slow to assert themselves and reap the advantages which nature so freely offers.

In Colombia coal fields are extensive; the country is rich in precious stones; gold and silver deposits are abundant; so is iron; and none of these resources are yet developed.

The chief wealth of Bolivia is its mineral deposits, but insufficient communication has retarded their development. They include gold, silver, a superior quality of copper, tin, lead, bismuth, mercury, platinum, iron, zinc, coal, rock crystal, alum, magnetic ore, talc, emeralds, opals, agate, and alabaster. There are also in Bolivia many kinds of marbles, slates, pumice stone, granite, syenite, porphyry, basalt, chalk, saltpetre, borax, and magnesia in more or less abundance.

EXPORTED TO SOUTH AMERICAN COUNTRIES, 1889.			IMPORTED FROM SOUTH AMERICAN COUNTRIES, 1889.	
Value.	Per cent.		Value.	Per cent.
$177,241,778	35.04	United Kingdom	$ 89,484,508	15.52
109,952,100	21 73	France	127,015,687	22.03
90,804,640	17.95	United States	207,384,389	35.97
52,237,906	10.33	Germany	86,513,714	15.01
33,207,666	6 56	Belgium	44,604,167	7.74
28.774,150	5 69	Spain	15,425,278	2.68
13,649.925	2.76	Italy	6,093,294	1.05
$505,868,165	100.00	Total	$576.521,037	100.00

There is not a country in South America that does not abound in mineral wealth as well as in rich soil and precious woods. Why is it that American investors are not more closely identified with these fields? Why is the balance of trade so much against us? Here is a market of over fifty millions of people at our very doors, so to speak, the people naturally leaning towards us, and desiring greater commercial intercourse with us. Yet their market is now held by Great Britain, Germany, France, Spain, Italy, and Belgium.

The manufacturers of those countries are in no better condition to supply the consumers in Latin America than are those of the United States. It is not assuming too much to say that the South Americans are as different from the nations of Europe in their habits and tastes, and in what they choose to consider their requirements, as from ourselves. If, in these respects, they have anything at all in common with any nations of Europe, those nations are Spain and Portugal. And Spain and Portugal may be said to have no commerce at all with them.

It has been the custom of American manufacturers to export to South America whatever they could not easily dispose of at home. The manufacturers in Europe of cottons, woolens, silks, laces, leather goods, boots and shoes, iron ware, manufactures of wood, machinery, novelties, stationery, and, in fact, everything the people of South

America use, have always adopted different tactics with the markets of South America, and, in fact, with the markets of the world. Their policy is to study the people's tastes and habits, and to make themselves masters in the knowledge of every detail of every requirement.

Having mastered the knowledge of the requirements of the people, they set about meeting them. And they do meet them. They obtained a foot-hold in Latin America, where they continue to hold the markets against all comers. This is particularly true in the case of Great Britain.

It should be unnecessary to give views on the natural advantages that would result, both to the countries south of us and to ourselves, from more intimate trade relations. They are many and obvious. The people of Latin America, not of course including the negroes and native Indians, are an esthetic people. To sell to them we must study their tastes, and throw over our own ideas of what is best. If our practical and generally tall women want common-sense shoes, and the artistic women of the Latin republics want high French-heel shoes, then we must keep our common-sense shoes at home, and make a high-heel shoe with needle points to sell to our dainty sisters in the south.

The first most advisable line of procedure in planning to sell to South America is to have one or more clerks at home who are thoroughly familiar with the Spanish language. And even of more importance is it to send to South America only agents who thoroughly understand the language, having the address and education necessary for intercourse with a people naturally polite and inclined to be diplomatic. No people can be rightly studied unless the student is familiar with their language. One might as well expect to master a special science before becoming acquainted with its nomenclature.

In conclusion, I may say that I am firmly convinced, from my intimate knowledge of the people and countries of South America, that, if the methods described were to be carried out by American manufacturers and capitalists, their success in southern markets would be assured.

GOLD MINING IN THE SOUTHERN STATES.

By H. B. C. Nitze.

DURING the early years of the sixteenth century the published accounts of various Spanish explorers of the New World reported the existence of gold in the southeastern part of what is now the United States; and many traditions are still extant of their discoveries,—for instance, the Brewer mine in South Carolina, where DeSoto is supposed to have mined for gold.

The aboriginal inhabitants of our continent are also credited with having sought after and discovered the yellow metal, and the sites of their ancient workings are still pointed out in the Nacoochee valley of Georgia, and elsewhere.

It is, however, impossible to name the precise date of the first discovery of gold in the United States. In all probability some mining was done previous to the Revolutionary war, but no authentic references to this can be obtained. In 1782 Thomas Jefferson, in his "Notes on Virginia," mentions the discovery of a piece of ore, containing gold, on the Rappahannock river. In 1799 a nugget, weighing seventeen pounds, was accidentally discovered on the plantation of Mr. John Reed in Cabarrus county, North Carolina. The story is current that Mr. Reed, in ignorance of the true nature of the metal, used it as a door-prop until 1802, when he was told that it was gold by a jeweler in Fayetteville, to whom he sold it for three dollars and a half. In 1803 a twenty eight-pound nugget was found in the same locality,—the largest nugget on record in the eastern United States. Regular mining work was commenced shortly afterwards; other discoveries followed; and the date 1804 may be fairly accepted as that of the first real excitement in the gold fields of the southern United States.

The earliest record of a domestic gold deposit in the United States mint was in 1804, and from that year until 1828 (inclusive) North Carolina furnished all the gold produced in this country, amounting to $110,000. During 1829 $2,500 was received from Virginia, and $3,500 from South Carolina. The first returns from Georgia appear in 1830, from Tennessee in 1831, from Alabama in 1840, and from Maryland in 1868.

Below are given several statistical tables, which explain themselves. These figures include, besides the United States mint and assay office receipts, all such bullion as went abroad, or was used directly by local jewelers or otherwise, and represents as nearly as possible the total product of the southern gold mines.

Table I shows the comparative fluctuations in the production for

TABLE I.—GOLD AND SILVER* PRODUCED IN THE SOUTHERN STATES AND DEPOSITED AT THE UNITED STATES MINT AND ASSAY OFFICES FROM 1793 TO 1894 INCLUSIVE.†

Year.	Amount.	Year.	Amount.	Year.	Amount.
1793–1823	$ 47,000	1847	$1,018,079	1871	$ 138,791
1824	5,000	1848	850,692	1872	164,461
1825	17,000	1849	891,968	1873	158,952
1826	20,000	1850	658,605	1874	141,647
1827	21,000	1851	500,539	1875	150,612
1828	46,000	1852	711,449	1876	138,256
1829	140,000	1853	486,184	1877	159,009
1830	466,000	1854	323,489	1878	162,925
1831	519,000	1855	362,349	1879	186,123
1832	678,000	1856	325,820	1880	203,770
1833	868,000	1857	141,810	1881	197,084
1834	898,000	1858	349,323	1882	229,459
1835	686,300	1859	379,677	1883	272,046
1836	667,000	1860	231,398	1884	255,259
1837	282,000	1861	141,778	1885	239,963
1838	358,750	1862	6,298	1886	272,414
1839	429,648	1863	1,624	1887	390,531
1840	427,311	1864	6,093	1888	234,947
1841	544,661	1865	33,345	1889	224,323
1842	723,761	1866	202,000	1890	269,997
1843	1,050,100	1867	106,903	1891	254,707
1844	928,095	1868	155,660	1892	262,023
1845	986,849	1869	191.738	1893	261,904
1846	992,792	1870	168,057	1894	273,072
					Total, $25,289,420

TABLE II. ESTIMATE OF THE PRODUCTION OF GOLD AND SILVER IN THE SOUTHERN STATES FROM 1799 TO 1879, AND ANNUALLY SINCE.‡

Years.	Md.	Va.	N. C.	S. C.	Ga.	Ala.	Tenn.	Total.
1799–1879	$2,500	$3,091,700	$19,659,600	$2,587,900	$14,180,500	$365,300	$155,300	$40,042,800
1880....	250	11,500	95,000	15,000	120,000	1,000	1,500	244,250
1881....	500	10,000	115,000	40,000	125,000	1,000	1,750	293,250
1882....	1,000	15,000	215,000	25,000	250,000	3,500	250	509,750
1883....	500	7,000	170,000	57,000	200,000	6,000	750	441,250
1884....	500	2,500	160,500	57,500	137,000	5,000	300	363,300
1885....	2,000	3,500	155,000	43,000	130,000	6,000	300	345,800
1886....	1,000	4,000	178,000	38,000	153,500	4,000	500	379,000
1887....	500	14,600	230,000	50,500	110,500	2,500	500	409,100
1888....	3,500	7,500	139,500	39,200	104,500	5,600	1,100	300,900
1889....	16,962	4,113	150,174	47,085	108,069	2,639	750	316,330
1890....	16,962	6,496	126,397	100,294	101,318	2,170	1,001	354,638
1891....	11,264	6,699	101,477	130,149	80,622	2,245	510	332,975
1892....	1,000	5,002	90,196	123,881	95,251	2,410	1,006	318,755
1893....	114	6,190	70,505	127,901	100,375	6,362	250	311,787
1894....	978	7 643	52,927	98,763	99,095	4,092	320	263,827
Total..	$46,068	$3,203,443	$21,709,276	$3,581,263	$16,101,730	$410,827	$166,105	$45,227,712

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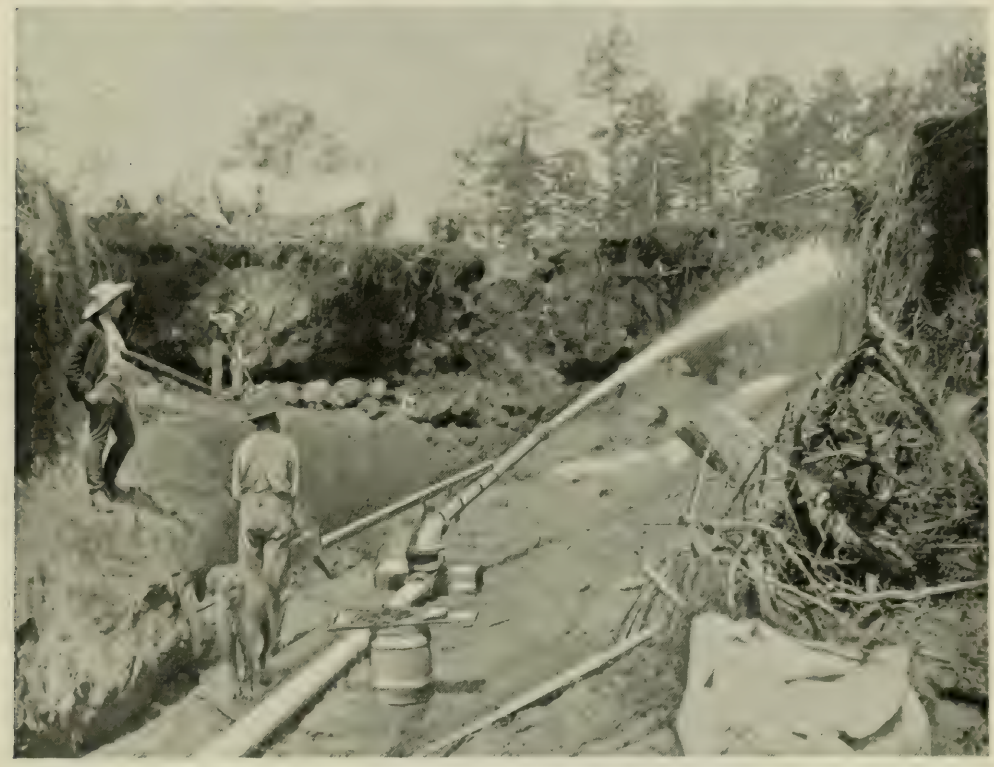
* The silver production is so small that for practical purposes it may be overlooked; hence the figures in this table and that following may be applied to gold alone.

† From the reports of the director of the United States mint.

‡ From the production report of the director of the mint, for 1892, and annual reports since.

various years. The early mining, as in all gold regions of the world, was confined to the stream gravel deposits and other shallow placers. The marked decrease in the production during the few years following 1834 may be explained by the partial exhaustion of these more accessible virgin placers. It was at this period that attention began to be paid to vein mining, and from 1837 to 1849 there was an enormous increase in the production, with few retrogressions; in the forties the south reached its maximum annual output, approximating $1,000,000. In the early fifties the California excitements distracted the interest from the southern fields, and an era of decreased production set in, which culminated in practical cessation during the civil war. Since then there have been periods of revival and depression, due to many minor causes; of late the annual production has been something over $250,000.



HYDRAULIC MINING. PARKER MINE, STANLY CO., N. C.

In order to institute a comparison between the present gold production of the southern States and that of the principal gold fields of the world, the following statistical table* is presented, showing the production in the south for 1894 to have been $263,827.

It is thus evident that the south is a very small factor in the gold production of the world, and that, in comparison with the other gold fields of the world, it stands last.

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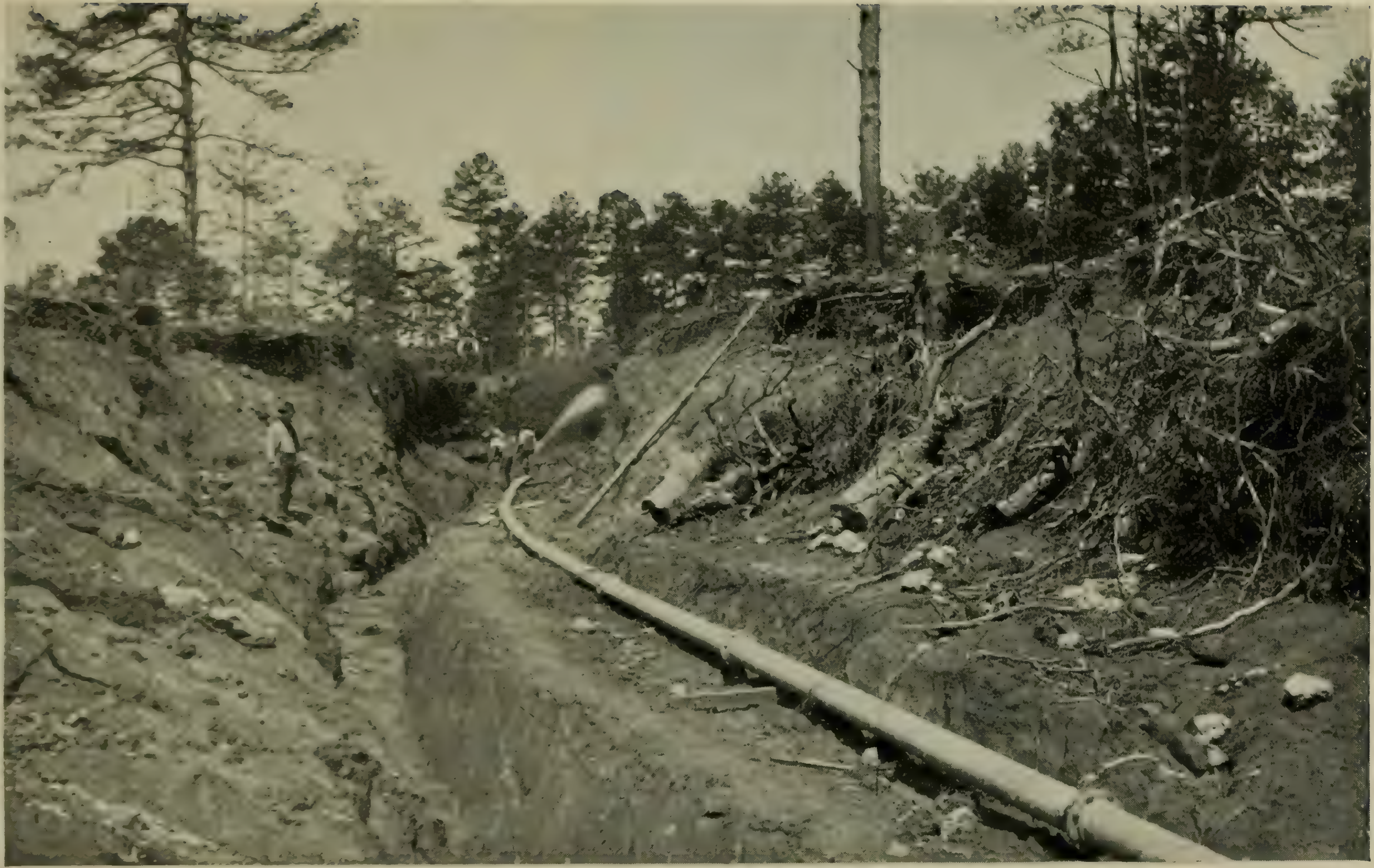
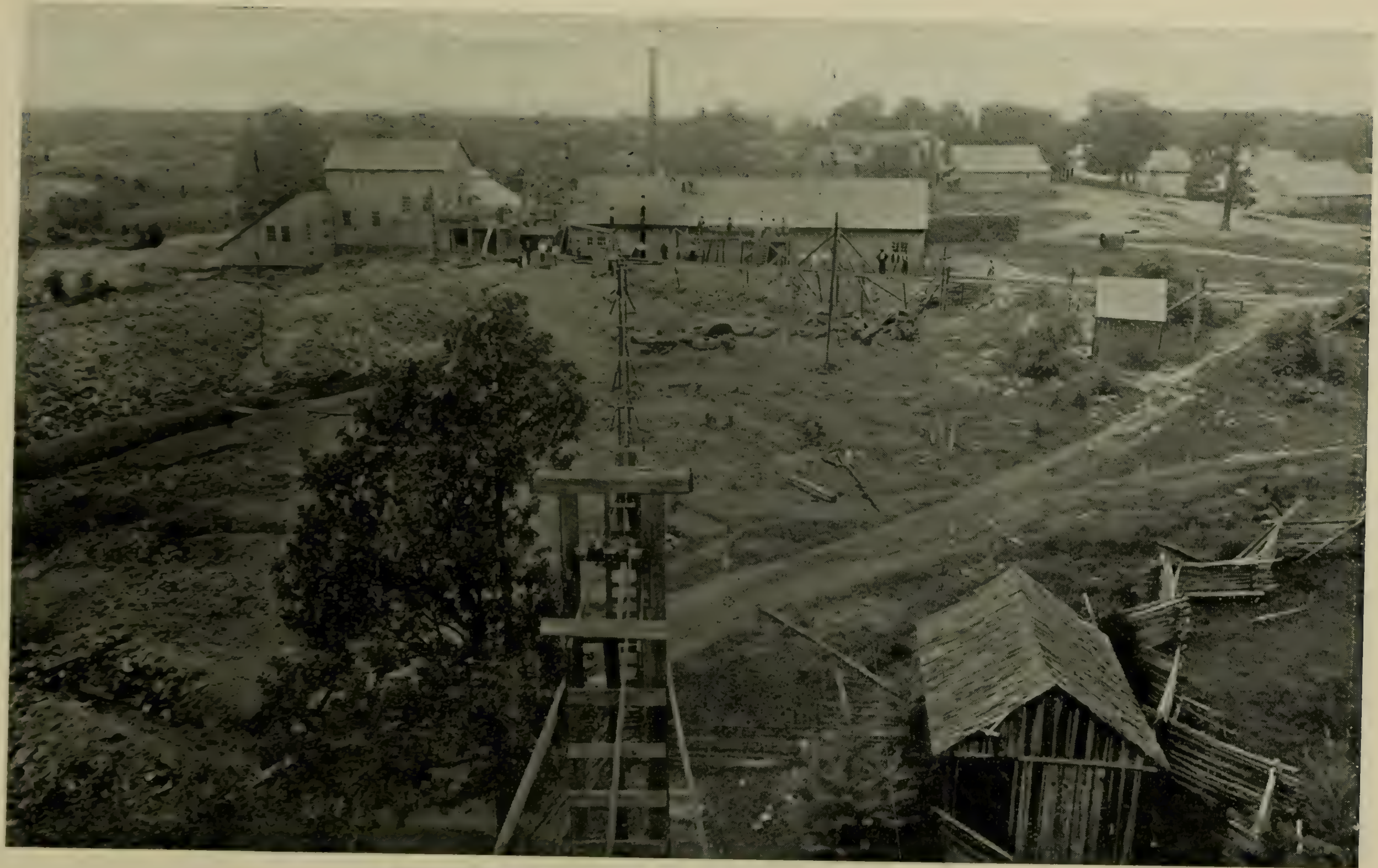
* From the report of the director of the United States mint for 1894.



HYDRAULIC MINING. PARKER MINE, STANLY CO., N. C.

STAND PIPE. PARKER MINE, STANLY CO., N. C.

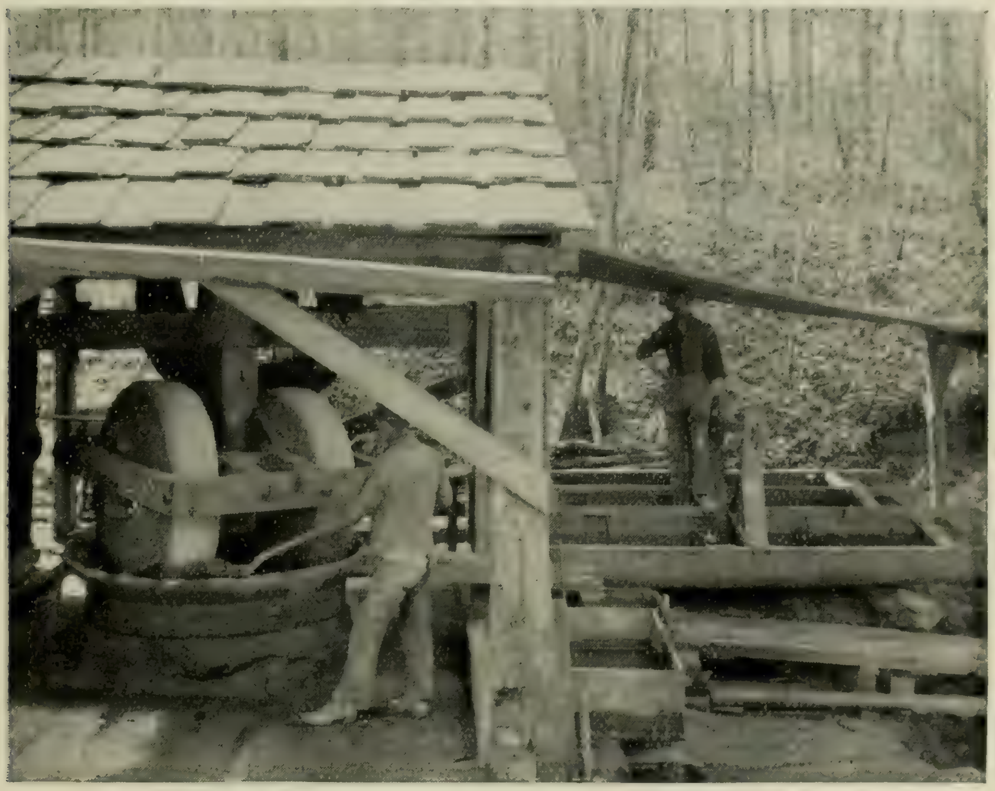
SLUICES. PARKER MINE, STANLY CO., N. C.



BARNHARDT SHAFT AND EAMES MILL, 1893. GOLD HILL, N.C.

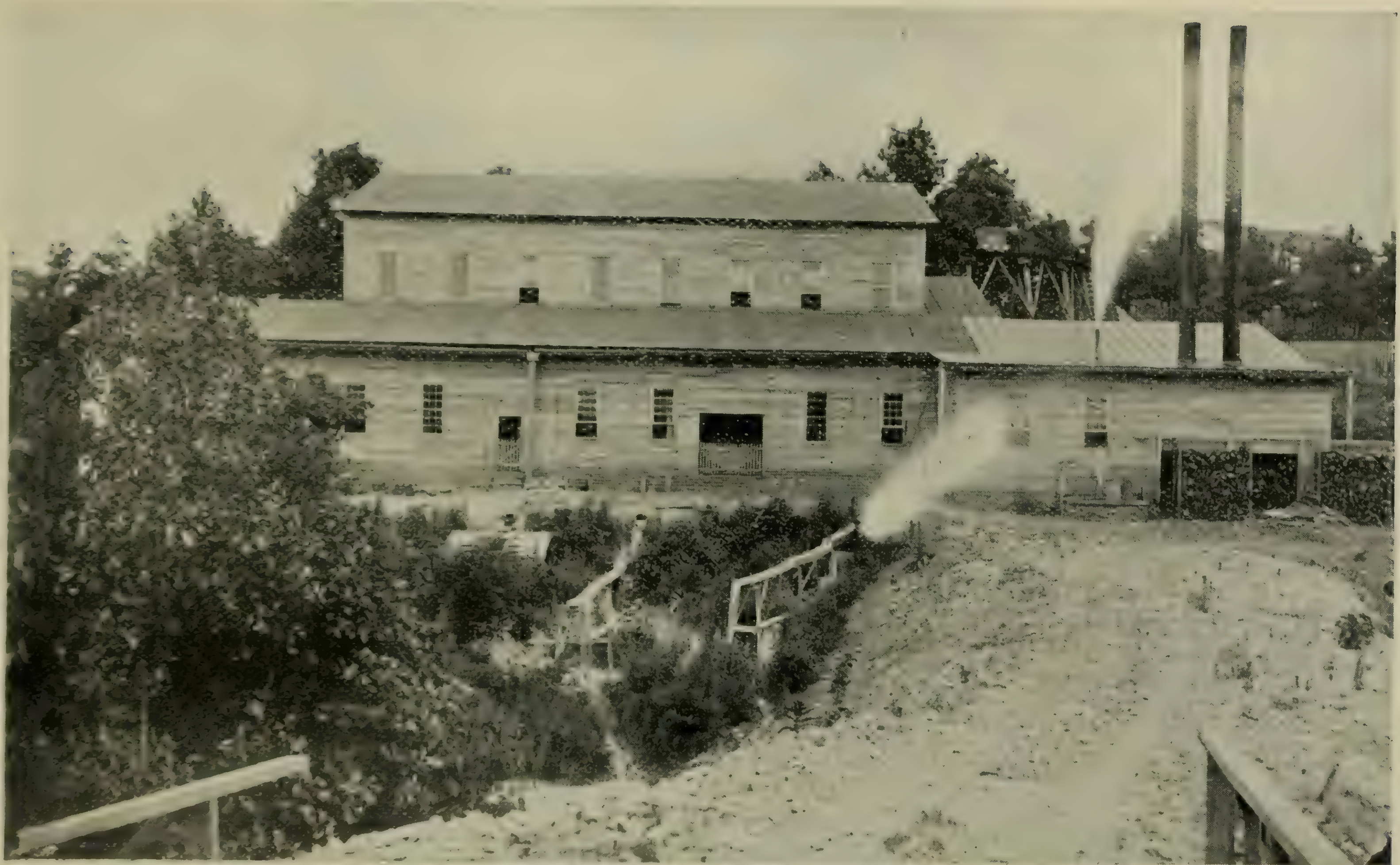
California	$13,570,397	Australasia	$41,760,800
Colorado	9,491,814	Africa	40,271,000
Montana	3,651,410	Russia	24,133,400
South Dakota	3,299,100	China	8,356,800
Idaho	2,081,281	Mexico	4,500,000
Arizona	1,784,475	India	3,986,900
Oregon	1,422,056	U. S. of Colombia	2,892,800
Nevada	1,137,819	Brazil	2,219,500
Alaska	1,118,550	British Guiana	2,310,100
Utah	868,031	French Guiana	1,329,200
New Mexico	567,751	Austria-Hungary	1,684,800
Washington	195,100	Germany	1,498,900
United States, total	39,500,000	Canada	1,042,100
Total of the world	$179,965,600		

The gold ores of the southern Appalachian States occur in the Piedmont and Mountain regions throughout the great belt of crystalline and metamorphic rocks stretching in a southwesterly direction from Maryland to Alabama, 600 to 700 miles in length, and 50 to 150 miles in width. This broad area may be subdivided into several minor gold-bearing belts: (1) the Virginia belt; (2) the eastern Carolina belt; (3) the Carolina slate belt; (4) the Carolina igneous belt; (5) the King's Mountain belt; (6) the South Mountain belt; (7) the Georgia belt; (8) the Alabama belt.



CHILIAN MILL AND ROCKERS. NEAR GOLD HILL, N. C.

The Virginia belt extends from Montgomery county, Md., in a southwesterly direction to the North Carolina line. Its width is from 9 to 20 miles, and the principal mining sections lie in Fauquier, Culpepper, Stafford, Orange, Spottsylvania, Louisa, Fluvanna, Goochland,



THIRTY-STAMP MILL. CATAWBA MINE, N. C.

GENERAL VIEW, CATAWBA MINE, KINGS MOUNTAIN, N. C.

and Buckingham counties. The rocks are gneisses and schists, striking N. 20° to 30° E., with easterly dips.

The eastern Carolina belt comprises an area of about 300 square miles in Halifax, Warren, Nash, and Franklin counties. The rocks are dioritic eruptives and chloritic schists, striking N. 50° to 60° E., and dipping southeast.

The Carolina slate belt embraces an area from 8 to 50 miles in width, extending in a southwesterly direction across the central part of North Carolina into the northern part of South Carolina, where it appears to sink beneath the coastal plain, and reappears in the eastern part of Georgia. The rocks are metamorphosed sedimentary slates and schists, at times highly silicified, and devitrified ancient volcanic rocks, often sheared. The strike is N. 20° to 55° E., and the dip steeply towards the northwest. Dikes of diabase are of frequent occurrence.

The Carolina igneous belt adjoins the slate belt on the west, and has a width of from 15 to 30 miles. The auriferous portion embraces an area of about 1,000 square miles. The rocks are granitic, dioritic, gabbroitic, and diabasic eruptives.

The King's Mountain belt lies to the west of the igneous belt, extending across North Carolina. The productive points are widely scattered, and constitute a small aggregate area. The rocks are gneisses and schists, with some siliceous limestones, having northeast strike and southeast dip.

The South Mountain belt begins in the western part of North Carolina, in Caldwell, Burke, McDowell, and Rutherford counties on

SAMPLING ORE. LOCKHART MINE, ONE MILE EAST OF DAHLONEGA, GA, the eastern flanks of the Blue Ridge, and extends into the northwestern part of South Carolina. The rocks are dioritic and granitic gneisses, striking northwest and southeast with gentle northeast dips over a large part of the area, and also northeast and southwest with southeast dips.

The Georgia belt begins in the northeastern corner of the State, and extends in a southwesterly direction to the Alabama line. Its maximum width is 30 miles. The rocks are very similar to those of the South Mountain belt.

"LOWER CUT," CHESTATEE PLACER MINE. NEAR DAHLONEGA, GA.

The Alabama belt is a continuation of the Georgia belt in Alabama, and constitutes the southwestern extremity of the southern gold field. The rocks are argillaceous slates and mica-schists and gneisses.

Of all these belts, the Carolina slate, the Carolina igneous, and the Georgia are the best developed, and perhaps the most important.

The gold-ore deposits are of three main structural types:

(1) The placer deposits, which may again be subdivided into (*a*) stream gravel deposits in both present and ancient channels, (*b*) gulch deposits, concentrated by means of secular movements, independent of fluviatile action, and (*c*) the saprolite* deposits, or the decomposed country rock in place.

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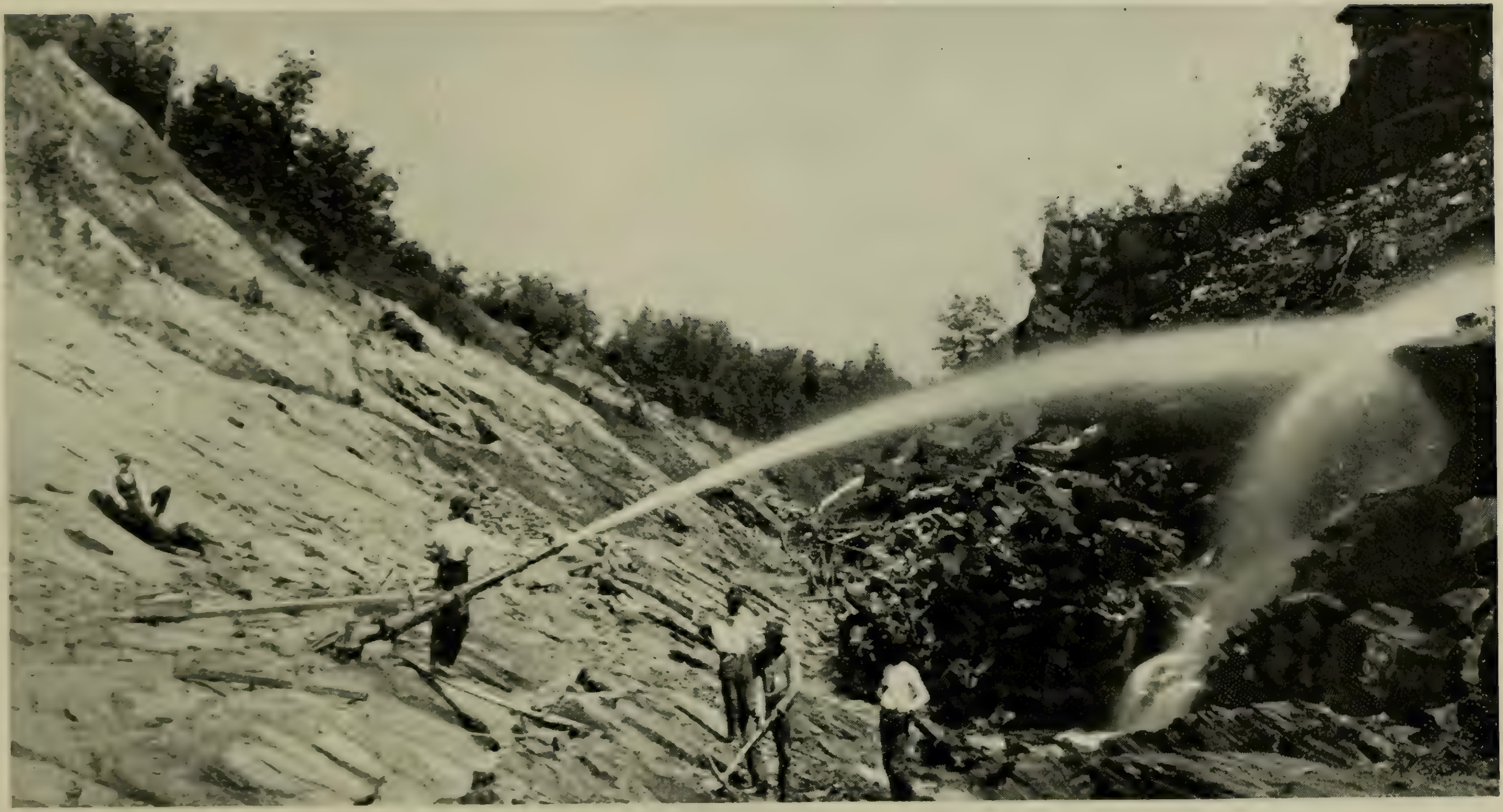
* The word "saprolite" is derived from the Greek, signifying rotten rock, and was first applied by Mr. Geo. F. Becker of the United States geological survey. The depth of the saprolites in the southern States varies from 25 to 100 feet.



HYDRAULIC MINING. BARLOW MINE, DAHLONEGA, GA.

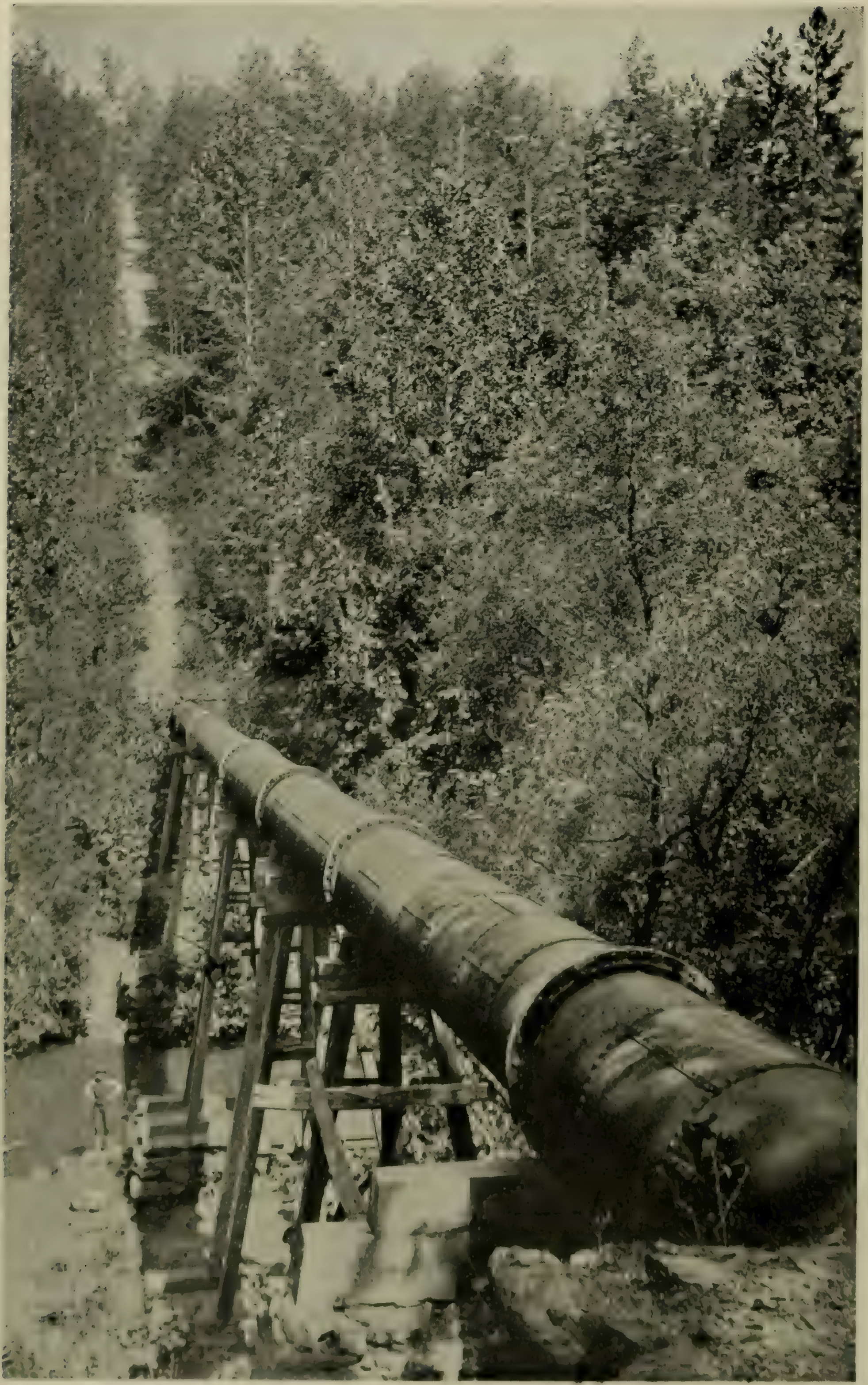
(2) Quartz fissure veins, containing free gold and gold in combination with sulphurets, which may in turn be differentiated into *(a)* clean cut fissures of some persistence, *(b)* a system of smaller and larger lenticular veins, approximately conformable to the schistosity of the rocks, but also intersecting the same, usually at small angles, and *(c)* a system of reticulated veins.

(3) Impregnations of free gold and finely-divided auriferous sulphurets in the country schists and slates, sometimes accompanied by small lenticular quartz intercalations. These auriferous schists are at times hundreds of feet in width, though not necessarily capable of being profitably worked over their whole extent; they constitute the low-grade ore bodies of the south.

The character of the ores is not unlike that of most other gold fields. The chief gangue mineral of the fissures is quartz, varying from saccharoidal to vitreous, and containing fragments and partings of the country rocks. Barite, calcite, and siderite are of occasional occurrence. At one locality (King's Mountain mine, N. C.) the veinstone is largely siliceous magnesian limestone.

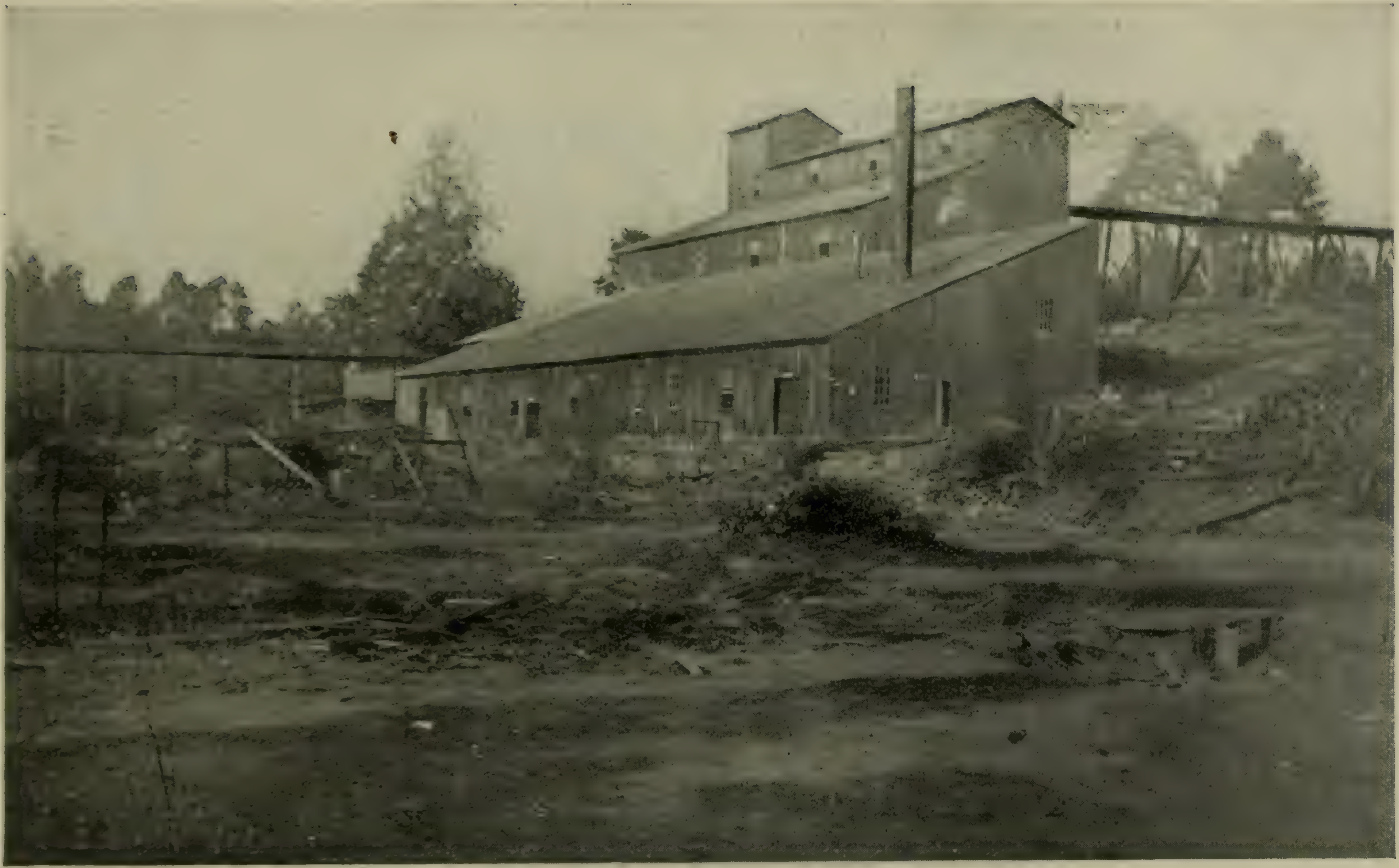
WATER POWER PLANT OF THE CHESTATEE COMPANY, DAHLONEGA, GA.

In the auriferous slate deposits irregular lenticular quartz stringers are almost always present, and the slates are generally silicified in varying degrees up to such hardness that they resist scratching with a knife.

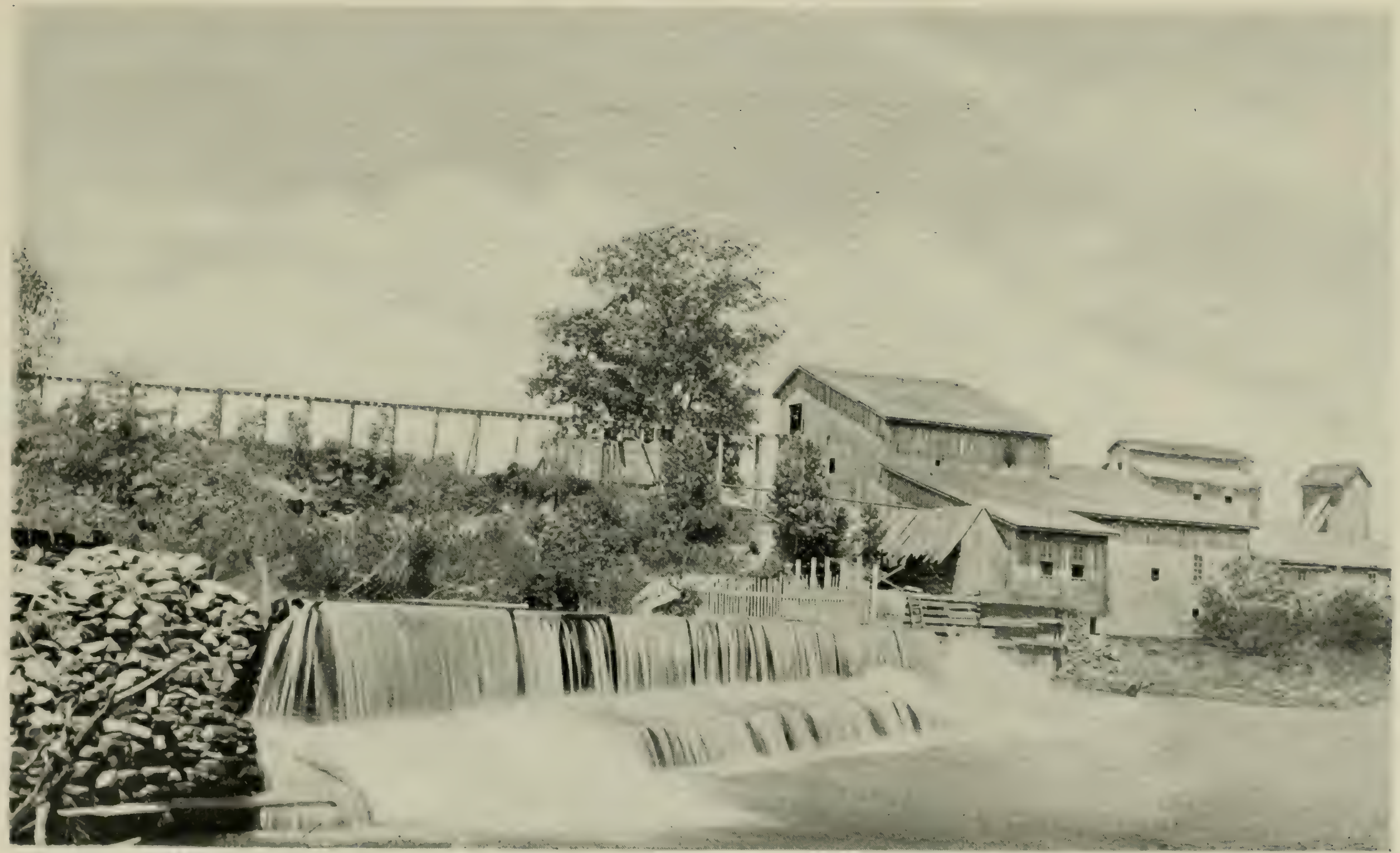


WROUGHT IRON SIPHON (3 FT. INSIDE DIAM.), 2000 FT. LONG ON THE HAND-BARLOW DITCH LINE. CROSSING THE YAHOOLAH VALLEY ONE MILE FROM DAHLONEGA, GA.

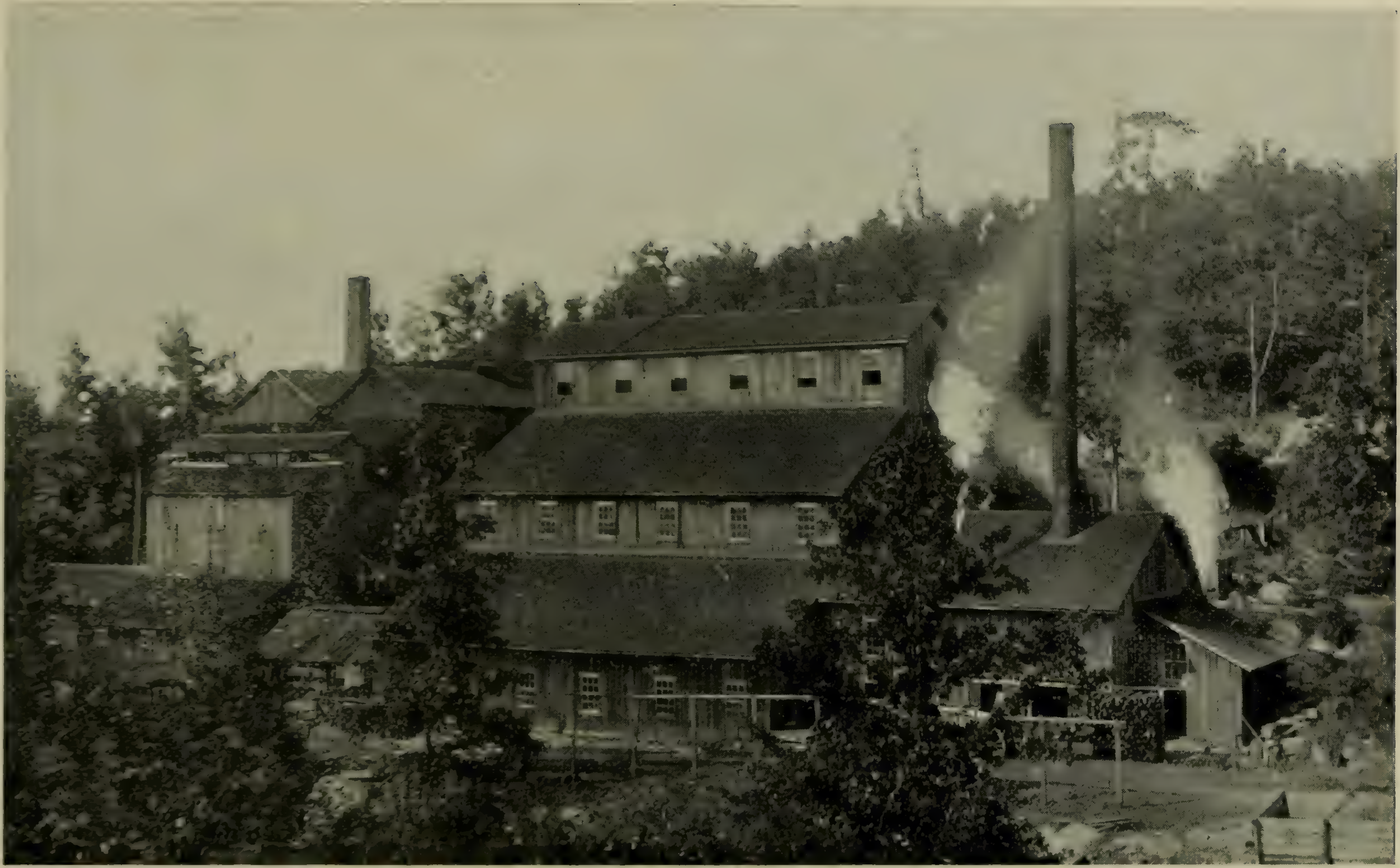
BIG CUT. RUSSELL MINE, GLEN BROOK, N. C.



FORTY-STAMP MILL AND CYANIDE PLANT. RUSSELL MINE, MONTGOMERY CO., N. C.



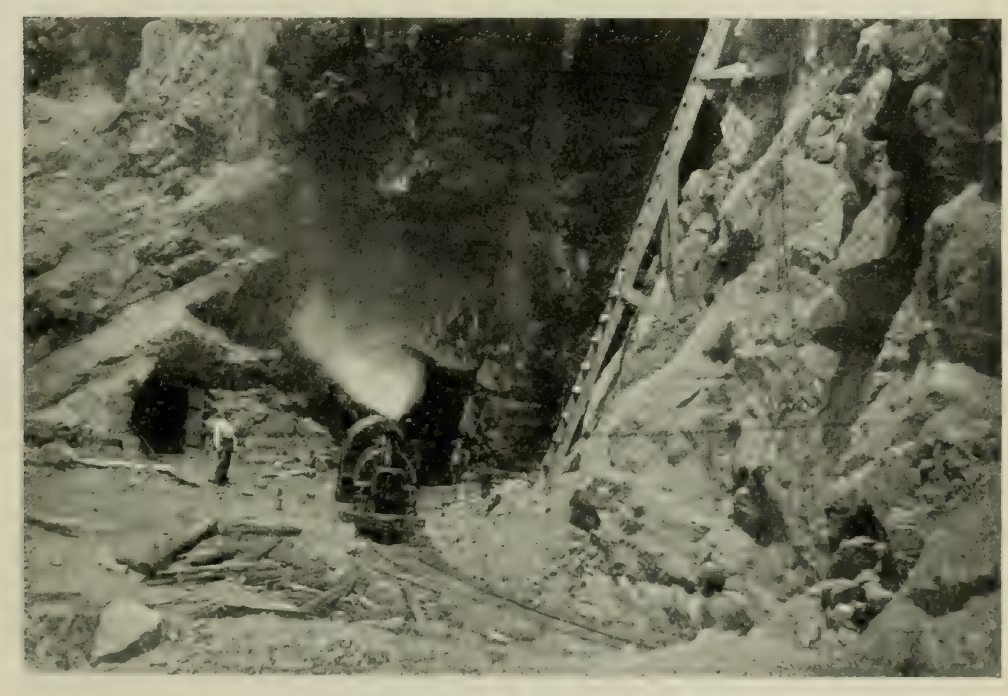
WATER POWER, STAMP MILL, AND CHLORINATION PLANT. FRANKLIN MINE, GA.



FORTY-STAMP MILL AND CHLORINATION WORKS. BREWER MINE, S. C.

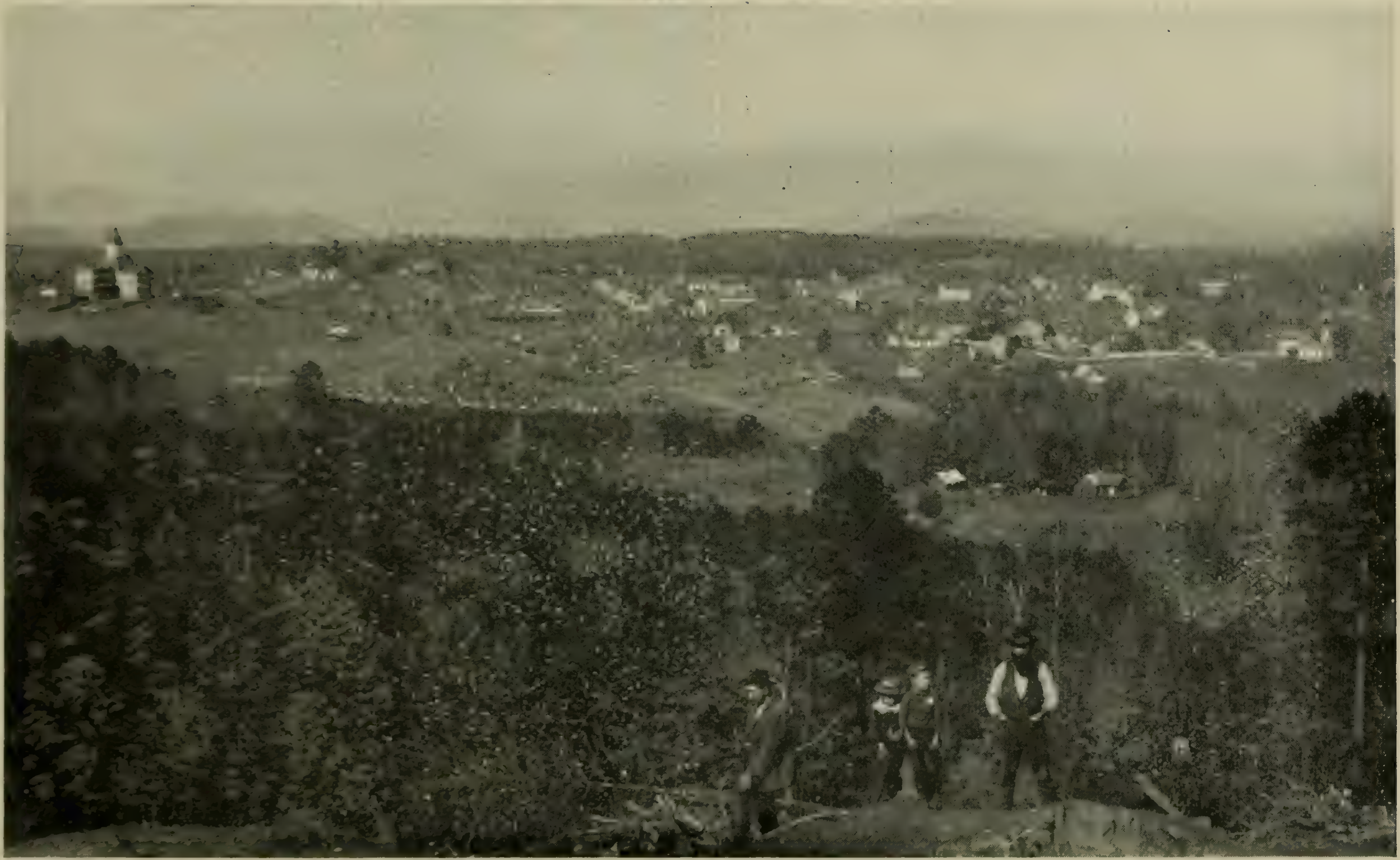
Below the water level, which occurs usually twenty-five to fifty feet below the surface, sulphurets make their appearance. These are mainly pyrite, though chalcopyrite, galena, and zinc-blende are frequently present in certain localities, and mispickel is comparatively rare. In certain groups of mines, particularly in the Carolina igneous belt, chalcopyrite often predominates. In a few localities (Silver Hill, Silver Valley, and other mines, N. C.) galena and zinc-blende predominate, and are high in silver; but these complex sulphurets have never been worked to any important extent, owing to the metallurgical difficulties attending their treatment. Tellurids are of very rare occurrence in southern ores.

It is of course difficult to give any fair idea of the value of southern ores. In the placer gravels this is well-nigh impossible, as no systematic records are at hand, and it is doubtful if any were ever kept. Compared with other gravel deposits, as those of California or New Zealand, the area and extent of the southern deposits are very limited. The virgin ground undoubtedly yielded handsome returns, though it was imperfectly worked, for many of the old tailings dumps have been washed over a second, third, and even as often as a seventh time at a profit. Channels running as high as $20 per cubic yard are recorded, but perhaps the vast majority of the ground worked yielded between 25 cents and $1.00 per cubic yard.



NORTH TUNNEL. BREWER MINE, S. C.

The auriferous saprolite bodies of the Dahlonega district in Georgia



BIRD'S-EYE VIEW OF DAHLONEGA FROM PREACHER GOLD MINE.

are exceedingly variable in value. Certain small quartz stringers may run up very high. Material as low as 40 cents per ton (equal to 12 cents per ton material mined) has been milled at a profit, but, as a rule, the grade of the mill-stuff is somewhat higher.

It is impossible to make any reliable statements regarding the quartz veins, the variation is so great. However, it may be said that generally the concentrated sulphurets run from $30 to $40 per ton,—*i. e.*, after the extraction of the free-milling portion, which may be from 20 to 50 per cent. of the value of the ore. The large bodies of low-grade auriferous schists may yield anywhere from $2.00 to $5.00 per ton in quantity.

Placer mining was the first mode of winning gold in the south, and many of the mechanisms now used universally, such as the rocker and long tom, originated here. At the present day very few gravel mines are in operation. Of those that are, two classes may be named: (1) operations on virgin deposits; (2) operations on ground that has already been worked.

Of the first a good example is the Crawford mine in Stanly county, N. C., four miles southeast from Albemarle. It was first opened in 1892. The gravel bed, composed of angular quartz and slate fragments in a clay matrix, occurs in a narrow stream bottom, perhaps 250 feet in width. Its thickness is 1½ to 2 feet, and the overlay is from 2 to 4 feet deep Owing to the scarcity of water here, a novel method of washing is pursued. A wooden tank, of 200 cubic yards capacity, is situated at some elevation above the stream bed. At one end is a standpipe 30 feet high, which is supplied with water from a reservoir below, by a steam pump. The gravel is hauled to the top of the tank in tram-cars and dumped. Here it is washed by the discharge from the standpipe. A line of riffled sluice-boxes runs from an opening in one side and near the bottom of the tank. The gold is collected from the bottom of the tank, and from the riffles in the sluices. It occurs almost exclusively in the shape of nuggets; no quicksilver is used. In April, 1895, an 8-pound nugget was found, and in August of the same year one weighing 10 pounds. The cost of working is estimated at about 50 cents per loose cubic yard.

Of the second class, the Mills property at Brindletown, Burke county, N. C., is perhaps the best example. During the past summer extensive preparations were in progress to work the old tailing heaps of Silver creek valley, by the use of hydraulic giants and gravel elevators. Other placer mines that attained some importance at one time or another in the south are the Sam Christian, Montgomery county, N. C.; the Parker mine, Stanly county, N. C.; Nacoochee Valley, Ga.; Arbacoochee, Ala.; etc.

The Chestatee company, near Dahlonega, Ga., is now at work hydraulicking a canal, half a mile in length, into which to turn the Chestatee river, from its present course, and expose its bed of auriferous gravel for mining operations.

A unique method of mining is practised in the Dahlonega district, Ga., consisting of a combination hydraulicking, sluicing, and milling process. The ore bodies are the large masses of auriferous schists, decomposed to great depths (25 to 150 feet), which are cut down by hydraulic giants, and the material led through ground and box-sluices to the stamp mills, situated at some distance. The cost of mining and milling by this method is from 18 to 25 cents per ton milled.

The facilities for water in the southern mining camps are, as a rule, fair, though, as everywhere, beset with local difficulties. At the Sam Christian and Parker mines, for instance, expensive pumping plants and pipe lines, several miles in length, were necessary in order to obtain the requisite amount and head. On the Mills property some twenty miles of ditch and flume lines furnish the water, with a head of 60 to 200 feet. In the Dahlonega district there are over eighty miles of ditching, and two large siphon lines.

Of the quartz veins and mining it may be said that the free-milling gossan or brown ores of the upper decomposed zone are practically worked out by this time, and mining is directed to the deeper, sulphuretted, and, as a rule, less rich ores. One of the best examples of an actively-producing mine of this class is the Franklin in Cherokee county, Ga., sixteen miles northeast of Canton. The present mine workings are in the 350- and 430-foot levels. Four ore shoots, from 40 to 120 feet in length, and from 2 to 14 feet in width, have been opened. The dip is 40° S. E., and the pitch 45° N. E. The ore is quartz, carrying from 5 to 9 per cent. of coarse crystalline pyrites. About fifty per cent. of the gold is free milling, and is extracted by amalgamation in a 20-stamp mill, handling 35 tons per 24 hours. The concentrates produced from ten Embrey tables in 24 hours is 5½ tons. The tailings run about 85 cents. The concentrates are treated in a Thies chlorination plant, the tailings from which run about 60 cents, giving an extraction of over 95 per cent. The total cost of mining, milling, roasting, and chlorinating is $2.70 per ton of ore mined.

As the best example of a mine working on a large body of low-grade slate ore, the Haile in Lancaster county, S. C., three miles northeast of Kershaw, is cited. The auriferous bodies are lenticular in shape, about 200 feet in length and 100 feet in maximum width. The pitch is 50° to 60° N. E. and the dip 45° N. W. to vertical. The ore consists of silicified sericitic schists, impregnated with free gold and sulphurets (pyrite, from 2 to 25 per cent.). The average assay value is about $4.00 per ton. Diabase dikes intersect the ore bodies, and the richest ores are usually found in their vicinity. The greatest depth o the workings is 270 feet. The mill is a 60-stamp one, and treats 120 tons of ore per day; about 33 per cent. of the gold is free milling, and the percentage of extraction is from 75 to 80 per cent. The concentrates from twenty Embrey tables amount to about 8 tons per 24 hours, and assay from $25 to $35 per ton. They are treated in a three-barrel Thies chlorination plant, where the extraction averages 94 per cent. The cost of roasting per ton of roasted concentrates is $2.58. The cost of chlorinating per ton of roasted concentrates is $1.45. The cost of roasting and chlorinating per ton of raw concentrates is $3.02, and per ton of ore mined 19 cents.

It now remains to draw some general conclusions, and to present some idea of the possible future of gold mining in the south. The above examples, taken from the few successful mines in the field, must not be accepted as typical. They are cited because the mines are developed, and in order to show what can be done. Of the great number of mines that have at one time or another been in operation in the south but few are now working, and still fewer productively. The causes of mining failures are numerous. As in all other mining districts a certain number of failures must be attributed to the incapacity of the mine itself. At the same time good mines have been injured by speculative maneuvers and stock manipulations. The introduction of numerous patent processes and mechanical contrivances of unquestionable inferiority, often approaching the ridiculous, for crushing, amalgamation, and other metallurgical treatment, explains the failure of many a mine; yet often the blame was attached, not to the defects of the process (where it belonged), but to the ores tested. After the true free milling brown ores were practically worked out, many operations were continued on the deeper sulphuretted ores, employing simple amalgamation without attempting to recover the gold in the sulphurets, which escaped in the tailings in enormous quantities. Again, a very general mistake has been the erection of costly milling and other machinery, previous to the proper opening of the mines, and without having sufficient ore in sight to supply the works. One great drawback to investors is the fact that many of the mining properties, even though entirely undeveloped, are held by the owners at figures so unreasonable and prohibitory as to preclude any fair deal The sooner the folly of this is realized, the better. Capital is needed in the south to develop its mineral resources, and mine owners must remember that the cost of an undeveloped mine is only a part of the ultimate expense of putting it in working and producing order.

All of these mistakes are gradually being comprehended, and the advantages of chlorination, cyanid treatment, and smelting are becoming known. The stamp mill, very properly, is more tenaciously adhered to than ever for crushing purposes. The economic success of the chlorination process, for the treatment of concentrated sulphurets, with an extraction of 90 to 98 per cent., has already been practically demonstrated by the excellent work at the Haile, Franklin, and other mines. It is stated that recent experiments at the Russell mine in Montgomery county, N. C., have shown that treatment by the cyanid process will cost from 90 cents to $1.00 per ton, on a scale of 100 tons per day, with an extraction of 85 to 90 per cent. For such mines as the Silver Hill and the Silver Valley, the complex sulphurets (galena, zinc-blende, etc.) must be treated by smelting; and for this purpose copper ores are necessary. Suitable auriferous copper ores do exist in many of the mines, notably those of the Carolina igneous belt. The establishment of custom sampling works and metallurgical plants, of which not one exists in the south to-day, and the reopening of mines necessary to supply them, are not unfeasible undertakings, though they may be difficult, and will require capital. But the advantage to the south cannot be overestimated.

Regarding placer mining, more systematic work is necessary. One of the chief difficulties is the fact that the deposits are in many cases below drainage; to overcome this, the more general adoption of the hydraulic elevator is recommended.

The history of gold mining in the south would form a long chapter if it were attempted to give in detail the manifold conditions, the rise and fall of the numerous ventures, which have led to the present neglected state of the industry. Suffice it to say here, that, although no bonanzas can be expected, workable bodies of ore exist, which may form the basis of profitable mining operations, so long as these are confined to legitimate ends, governed by sound and capable business and technical management, and protected from the interference of patent charlatan processes. The treatment of low-grade sulphurets is the ultimate problem in almost every mining camp; and so in the south these must be the main source of its gold production. It is believed that the state of the industry is approaching a healthier condition, and that the preparations now in progress and the growing interest manifested in the development of the resources of the south point to a reasonable revival of gold mining, with an increased production, though it may be many years before it can attain even its former maximum production.

THE COMMERCIAL EXPLOITATION OF ELECTRICITY.

By Burton E. Greene.

THAT the electrical industry of the United States is not in a commercially healthy condition is known to every one engaged in it. That it has never returned to the investor any reasonable profit is equally well known, as is also the fact that the small army of patient and worthy inventors have received scant reward for their labors. The general public, or, at least, that portion depending upon the daily press for electrical information, does not perhaps realize this; but every man who has come into close touch with the industry acknowledges it with regret. It may be profitable, therefore, to review briefly the commercial development of the art, and to point out the reasons for the past and present unsatisfactory conditions.

To cure a disease, it is first necessary to know just what the disease is. And to purify the electrical trade, and effect a revolution and a reëstablishment upon sound and profit earning lines, it is necessary to consider the causes which have clogged its progress.

It is not within the scope of this article to take into account any applications of the art other than those of electric lighting and power, and these only in their commercial aspects. These branches of the industry may be said to be twenty years old, dating back to the organization of the Brush Electric Company about 1877. Little was done until after 1880, when capitalists generally began to take active interest, and when newspaper articles showing the marvellous possibilities became common. And it is not too much to say that even the "booming" articles in the daily press, prepared by paid agents of the manufacturing companies, were well within the bounds of truth as to the possibilities of development, except in the one important point of *the cost of producing power*. To the shame of some of our leading inventors, it must be admitted that these misrepresentations emanated chiefly from those who knew better, and the lay public was soon convinced that there were fabulous profits in the business. On this popular misconception promoters and speculators have worked ever since, to their own enrichment, but to the loss of millions of honestly-invested capital.

To the leaders in the science it was as well known in 1880 as today that electric lighting could never compete with gas on the score of economy. Yet the literature given out by one of the pioneer companies in incandescent lighting boldly claimed that gas-lighting was doomed, and with the untruth carried conviction so far that a general panic in gas stocks resulted. Upon these flat misrepresentations and misconceptions electric stocks were "boomed" to fabulous prices, one stock in particular selling at over $5,000 per share on a par value of $100. The public seemed ready to buy anything in the form of electrical securities. They had been educated to believe that electricity was a synonym for the touch of Midas, and the education had been conducted by experts.

Probably the fundamental cause of the large losses of capital with which the record of the trade has been blackened was that the commercial men who took control of the larger companies, in ignorance of the facts, pushed the business too rapidly. If a few more years had been spent in *developing* apparatus before forcing it upon the public, the results would have been different. One of the earliest salesmen in the trade recently said to the writer: "Up to 1885 we all knew that, when we had sold a man a plant, he had wasted his money; we knew the apparatus was not commercial; but we were hired to sell goods, and we sold them."

The stories of fabulous profits and quick results attracted an army of adventurers and speculators. Scores of men who had never made headway in any other undertaking thought they had found in the electrical business the long-looked-for opportunity of making money without honest labor. For years this class was conspicuously in the foreground, while the honest and hardworking inventor found it more and more difficult to secure legitimate reward for his labor. Many of these promoters and speculators were of small mental calibre, totally unfitted for the conduct of large enterprises. Gradually they sank to their proper level, but meantime the money of the misguided investor was being spent in extravagances and bad management.

Notwithstanding the handicap of incompetent business management, the inefficiency of the early apparatus, and the discouragement of pioneer investors, the business grew. It could not be prevented from growing. It is a fair estimate that up to to-day $750,000,000 have been invested in electric railway and lighting plants. Returns to stockholders in dividends have been insignificant. Why should this be so? No one reason can be considered sufficient to answer the question.

One of the curses of the business, from its inception, has been the insatiate desire to control, to drive out all competitors, to monopolize. This spirit permeated every one of the larger corporations throughout the period when the product was being sold at prices giving a profit of from three hundred to five hundred per cent. over shop cost. It was this spirit, conceived in arrogance, which, more than any thing else, shaped the policy of all, and caused the expenditure of millions upon millions in profitless patent litigation.

It has become quite the fashion in the trade to deride the American patent system, because so few electrical patents have been sustained. The fault, however, does not lie with the patent system. In fact, in many cases the invalidation of electrical patents has been, not a fault, but a credit to our American judiciary, who have grasped the truths which electrical men generally have ignored. Those in control have believed, or assumed to believe, that the art itself was born after 1880. They have ignored the facts of record,—that the fundamental principles had been for years taught in the leading schools, especially in Germany, England, and Scotland; that the commercial adaptation of well-understood foundation principles was scarcely in the nature of invention, but rather development,—the natural result of so many bright minds, fertile in expedients, laboring for a common end. Acting upon this misconception, each one of the large companies claimed for itself the sole right to do business, and a campaign of patent litigation and bluster never paralleled in the history of the world's business was begun. Up to a few years ago every man in this country, with any standing in and knowledge of the art, was under a regular retainer from one or another company. And, for all the vast sums expended, no one has reaped any considerable financial reward as the result of litigation.

More than this, the desire to control bred other evils, worse than wasteful litigation. It took such complete mastery of some of the leaders that the legitimate manufacturing and selling business was ignored, or left solely in the hands of minor employees, without experience and without judgment. Years were wasted in making trades, deals, and working arrangements, none of which have had any result other than preventing the achievement of substantial commercial success.

The third unfortunate feature which has marked the course of the electrical trade, more justly open to criticism than any other, more responsible for the distrust and suspicion with which electrical investments are now regarded, has been the manipulation of stocks by those in control of the prominent companies. This is a disease not easy to eradicate, but which must be eradicated before the trade will ever be upon a solid basis, and before the stockholder can be assured that the affairs of his company are being administered in his interest instead of for the personal enrichment of stock-jobbers and speculators. Up to 1890 speculation was in the air, tickers were placed in offices of the companies, and even humble employees were not discouraged from gambling in the securities of the company by which they were employed, or those of that company's rivals. Since 1893 speculation has been discouraged among the rank and file, but has been cultivated more assiduously than ever among the officers of some of the parent companies. That no officer of any corporation should speculate in the securities of his corporation is a proposition beyond argument. That no executive officer of a manufacturing corporation should speculate at all is equally beyond argument.

To this prevalent fever of speculation and stock-jobbing, may be traced many of the evils which have blotted the pages of the commercial history of the art in this country. Shares could be "boomed" only on a showing of large profits. Large profits could not be shown without a large gross business. Therefore, every effort was put forth to make the latter look as large as possible. The business was not left to develop itself. It was forced. The laws of commerce were ignored. Electrical companies did not wait for local capitalists to become sufficiently interested to invest in lighting or railway plants. The scope of what should have been solely a manufacturing company was widened to include the business of promoting, building, exploiting, financing, and running electric-light stations and railroads. Stocks and bonds were taken in payment for apparatus sold, and, though worth perhaps only fifty cents on the dollar, went into the sales account at par, making a paper showing of immense business. Financing companies were organized for the sole business of marketing these securities. Millions of bonds taken by the manufacturing companies at sixty were finally sold to the public at ninety. The inevitable result of this plan was the establishment of a large number of unprofitable plants, the over-capitalizing of nearly every plant so sold, and the flooding of the money markets with millions of securities on which the earning of interest was an impossibility. Thus even the legitimate branches of the business have been put under a cloud, and all classes of electrical securities have been smirched with suspicion; and this in the face of the undoubted fact that the best investments in America are those in electric-lighting and electric-railway companies, when capitalized at anywhere near their actual value.

No stronger proof is necessary that the general conduct of the business has been utterly wrong than the fact that, of all the large pioneer companies doing business before 1886, not one remains. They have either failed and gone out of business, or lost their identity in unfortunate amalgamations.

Reference has been made to the large number of speculators and promoters attracted to the trade in the earlier years. Added to the injury to the trade inflicted by the misguided management of companies established upon a legitimate foundation, there was the grosser injury suffered from the parasites and marauders who had nothing of merit to work on, and who organized companies solely for the sale of worthless stock, using the magic word electricity to float their schemes. As an object lesson, we lay before the readers of The Engineering Magazine the records of *one State* alone. The accompanying table shows the electrical manufacturing and selling companies incorporated in New York State from October, 1875, to November 9, 1895. The list does not include either railway or lighting companies, but all corporations, legitimate and illegitimate, whose business was to be the sale of apparatus, supplies, or patent rights. In every case *some stock was sold.* A careful perusal will show that the frauds and humbugs have been largely in the majority. The record is appalling as it stands,—nearly $412,000,000 for New York State,—but does not include the bonded and floating debt—merely the authorized capital stock. In several other States the operations of the schemers are in evidence on a scale of corresponding magnitude. Illinois, Maine, Massachusetts, Ohio, Pennsylvania, New York, and Connecticut aggregate not far from $1,800,000,000 paper capitalization for the same class of companies.

No one with the best interests of the industry at heart can look upon this record of stock-jobbing with other than feelings of misgiving and sorrow. It would be worse than useless to discuss the subject now, were it not that plenty of evidence exists to prove that the lessons of the past have not yet had the proper influence upon the electrical public. All evils of this kind gradually cure themselves, and it is gratifying to observe that conditions are steadily improving. There are to-day scores of concerns conducting their affairs in accordance with sound and established commercial principles. This could not be said ten years ago.

What has occurred is now a matter of history. What has the future in store? Founded upon the science of electrics, there is what may become the grandest industry of this or any other century. The *scientific* triumphs are beyond dispute. Can the industry be made profitable? It surely can. No better proof of this is needed than that companies which lost money ten or even five years ago are now making money, with product selling at from one third to one-fourth of what it was sold for then. Reforms have been inaugurated. They should be prosecuted with earnestness; and the power to *force* these reforms rests with the common stockholders in electrical manufacturing companies. Let them see to it that the speculative element is displaced in the management, and that conservative and experienced manufacturers are placed in charge. Let the lesson be thoroughly inculcated that speculation and speculative methods have no place in any manufacturing business.

ELECTRICAL AND MANUFACTURING COMPANIES INCORPORATED IN NEW YORK STATE FROM OCTOBER 18, 1875, TO NOVEMBER 9, 1895.

Arnoux Hochhausen Electric Co.	$ 100,000
American Dynamo Electric Machine Co.	5,000
American Electric Co	125,000
Alexander, Barney & Chapin, N. Y.	100,000
Am. El. Ry. Co., N. Y	1,000.000
" " Mfg. Co., N. Y	3,000,000
" " Time Co., N. Y	100,000
" " Const. Co., N. Y. (Limited)	20,000
" " " " " "	100,000
Am. Underground Electric Wire Co	1,000,000
Am. Electric Arms & Ammunition Co	1,000,000
Am. Electric Lamp Co	150,000
Am. Electric Transportation Co., N. Y	1,000,000
" Natl Tel. Co., N. Y	5,000,000
" El. Supply Co., Buffalo.	20,000
Alexander Chamberlain Electric Co.	1,000
American Electrical Publishing Co.	5.000
Atlantic Electrical Manufacturing Co.	100,000
Automatic Electric Railway-Signal Co.	3,000
Anglo-Am. El. Ass'n, B'klyn	100,000
Atlas Tel. & Tel Co., N. Y	10,000,000
" El. Co., N. Y	400,000
Automatic El. Power Co., N. Y	500,000
" " Current Arrester Co., N. Y.	100,000
" " Stock Machine Co., Castleton.	200,000
" " Lt. Co., N., Y	200,000
Averell Insulating Conduit Co. of N. Y.	5,000,000
American Electric Light Co.	500,000
Albany Electric Illuminating Co	100,000
American Electric Light Co.	400,000
American Electric Railway & Power Co	10,000,000
Ball El. Illt. Co., N. Y.	250,000
" " Lt. Co., N. Y	2,000,000
Balet El. Mfg Co., Bklyn	300,000
Bass " " "	50,000
Battery Lt. & Power Co., Buffalo.	1,000,000
Bergman El. & Gas Fixture Co., N. Y	250,000
" Gas & Electric Fixture Co.	100,000
Bishop G. P. Co., N. Y	40,000
Bock Elect. Co , N. Y	1,000,000
Bogota El. Lt. Co., N. Y	100,000
Brooklyn El. Time Co	50,000
" " Co	50,000
" " Lines Co	2,000,000
Buell El. & Pneumatic Co., N. Y	10,000
Ball Electric Mfg. Co., N. Y	500,000
Baxter Electric Lt. Co., N. Y	2,000,000
Bradley Electric Power Co., N. Y	1,000,000
Bonsilate Electric Mfg. Co,, Albany	100,000
Brooklyn Electric Const. Co	100,000
Brush-Swan Electric Lt. Co. of New England, N. Y	2,000,000
Buffalo Electric Wks	50,000
Barriett Electric Motor & Dynamo Co	20,000
Burton Electric Co.	10,000
Burlington Electric Land Association	60,000
Bentley-Knight El. Ry. Co , N. Y	1,000,000
Buell Electrical & Hydraulic Mfg. Co., N. Y.	500,000
Brush Electric Co	3,000,000
Brush Electric Illuminating Co.	1,000,000
Brooklyn Electric Light Co	2,500,000
Blanchard Electric Light & Power Co	1,000,000
Cabot El. Lt. & Mfg. Co	100,000
Central Imperial El Lt. Co	2,000.000
Chapman El. Motor Co , N. Y	500,000
Columbia El. L. & Mfg. Co., N. Y	1,500,000
Commercial U. S. Elect Supply Co	5,000
" El. Supply Co.	150,000
Connecticut Electric Mfg. Co	200,000
Carroll Electric Co	100,000
Cataract General Electric Co	8,000
Chapin-Douglas Electric Co.	10,000
Columbian Electric Co.	5,000
Columbia Electric Co	5,000
Consumers' Electrical Supply	1,000
Conteo Electric Co	15 000
Columbia Telephone Mfg. Co	$ 100,000
C. & C. El. Co	200,000
Central Electrical Co., N. Y	25,000
" Gas & El. Fixture Co., N. Y.	500,000
Cleveland Motor Co., N. Y.	50,000
Columbia Tel. Mfg. Co., N. Y	3,000
Commercial El. Co., Bklyn (Limited)	5,000
Constant Current El. Storage Co., N. Y.	15,000
Continental El. Co.	500,000
Consolidated El. Lt. Co.	2,500,000
Crocker-Wheeler El. Motor Co	100,000
Crosby El. Co., N. Y.	100.000
Crescent Electric Light & Motor Power Co.	500,000
Central N. Y. Electric Light & Power Co.	50,000
Daft El. Lt. Co	3,000,000
De Groot El. Co.	10,000
Drawbaugh Tel. Syndicate, N. Y	3,200.000
Dickinson Electric Supply Co.	10,000
Direct Acting Electric Gong Co.	15,000
Domestic Electric Mfg. Co.	500,000
" Thermo Electric Lt. Co , N. Y.	1,000,000
Dynamo Electric Power & Light Co.	5,000,000
Dynamo Electric Co	500,000
" Edison Co. for Isolated Lighting	1,000,000
Eastern Telegraph Co.	10,000
Elbridge Electrical Mfg. Co.	10,000
Electric Arc Light Co.	100,000
" Boiler Co. of Rochester, N. Y.	50,000
" City Land Co.	9,000
" City Mfg. Co. (Limited).	30,000
Eagle El. Co., N. Y.	2,000
Edison El. Fire Exterminator Co., N. Y.	500,000
Edison, Gilliland & Co., N. Y.	100,000
Ed. Genl. El. Co., N. Y.	12 000,000
Eickemeyer Dynamo Mach. Co., Yonkers	60,000
Eickmeyer-Field Co., N. Y.	1,000,000
Electric Steering Co., N. Y.	600,000
" Disinfection Co., N. Y.	200,000
" Locomotive & Ry. Supply Mfg. Co., N. Y.	1,000,000
" Educator & Supply Co.	250,000
" & Telephone U. G. Conduit Co.	1,000,000
" Bulletin Co.	25,000
" Locomotive & Ry. Supply Mfg. Co	1,000,000
" Appliance Co., N. Y.	20,000
" Mfg. Co., Bklyn.	100,000
" Lt. & Supply Co., N. Y.	10,000
" Power Co., N. Y.	700,000
" Fire Protective Co., N. Y.	300,000
Edison Electric Light Co.	720,000
" E. L. Co. of Europe (Limited)	2,000,000
Electric City Promoting Co.	20,000
" Construction & Supply Co.	12,000
" Engineering & Supply Co.	50,000
" Experimental & Developing Co.	43,000
" Inspection & Repair Co.	15,000
" Co. of Olean, N. Y.	40.000
" Metal Polish Co.	1,000
" Power	20,000
" Toy Co.	10,000
" Telegraph Co. of Westchester, N. Y.	10,000
Electrical & Mechanical Engineering & Trading Co.	150,000
" Engraving Co.	5,000
" & Mechanical Mfg. Co.	15 000
" Age Publishing Co.	5,000
Electrozone Co.	500,000
Empire Electric Co.	25,000
" State Telephone & Telegraph Co.	250,000
" State Electric Forging Co.	300,000
Electric Signal & Time Register Co., N. Y.	100,000
Electro Chemical Amalgamate Co.	10,000,000
Electrical Storage & Power Co.	100,000
" Const. Co.	10,000
" Candle Co.	200,000
" Accumulator Co.	5,000,000

Electric Arms Co	$1,000,000
Equitable El. Co., N. Y	5,000
Electric Ry. Co of the U. S.	2,000,000
" Conduit Const. Co	1,000,000
" Const. & Supply Co	120,000
" Storage & Mfg. Co	2,000,000
" Cutlery Co., N. Y	25,000
" Wiring & Const. Co., Bklyn	25,000
" Engineering & Supply Co., Syracuse	25,000
" Pneumatic Time Co., N. Y	100 000
" Co. of N. Y	100,000
" Mfg. & Gas Engine Co., Seneca Falls	100,000
Empire Electrical Mfg. Co., Bklyn	100,000
" Safety Lt., Heat & Power Co	5,000
" City El. Co	100,000
Enholm Electrical Const. Co., N. Y	100,000
Eureka El. Co., N. Y	100,000
Excelsior El. Apparatus Co., N. Y	10,000
" Genl. El. Co	15,000,000
Electric Sugar Refining Co., N. Y	1,000,000
" Ordnance Co., N. Y	1,000,000
Electrical Distribution Supply Co., N. Y	1,000,000
Electric Ry. Signal Co., N. Y	3,000,000
Edison Electric Light Co. of Havana	1,000,000
" Electric Light Co. of Porto Rico	1,000,000
Electric Motive Power Co	500,000
Excelsior Electric Co	500,000
Fuller Electrical Co	870,000
Franklin Electric Light Co	600,000
Faure Electric Storage & Light Co	2,000,000
Fitch Electric Lighting & Const. Co	100 000
Fithian Engine & Electric Light Co	1,250,000
Foster Electric Motor Co	100,000
Franklin & Faraday Electric Co., Ltd.	100,000
Faraday El. Cable Co , N. Y	100,000
Franklin El. Lt. & Power Co., N. Y	1,500
" " Mfg. Co., N. Y	25,000
Fuller-Wood El. Lt. Co., (Limited)	50,000
Globe El. Supply Const. Co	25,000
General Electric Co	50,000,000
Globe Electric Construction Co	20 000
Hall Telephone Co., N. Y	500,000
Herzog El. Appliance Co	140,000
" Teleseme Co. of N. Y. State	500,000
Hobby El. Lt. Co. of N. Y	50,000
Highland Falls Water & El. Power Co	15,000
Haldreze El. Motor Co., N. Y	20,000
Household El. Lt. Mfg. Co	500,000
Hercules Electric Co	5,000
Hecla El. Lt. Co., N. Y	5,000
Haddan Electric Ry. Signal Co	500,000
Hathaway El. Lt. & Power Co	10,000,000
Hussey Elect. Lt. & Power Co	1,000,000
Herzog Electric Co	110.000
Higgs Electric Lt. & Power Co	500,000
Howard El. Line Co., N. Y., Ltd	100,000
Home El. & Mfg. Co., N. Y	50,000
Hussey Electro Magnetic Motor Co	300,000
Higgs Electric Light & Power Co	500,000
Hussey Electro Magnetic Engine Co	100,000
India Rubber & Gutta Percha Co., N.Y	250,000
Industrial Lt. Co., N. Y	300,000
Interior Electrical Conduit Co., N. Y	150,000
Imperial Electric Lamp Co	250,000
International Electric Forging Co	6,000
" Telegraph & Telephone Co	5,000
Imperial Elect. Co	1,000,000
International Electric Exchange & Supply Co	300,000
International Electrical Co	24,000
Jablochkoff Electric Lighting Co	2,250,000
Jagel El. & Pneumatic Subway Co., N. Y	1,000,000
Johnstone U. El. Lt. & Power Co., N. Y	100,000
Keith Electric Co	800,000
Knudson Electric Co., N. Y., Ltd	10,000
Lugo Dynamo Electric Co	100,000
Levett-Muller Electric Light Co	1,000,000
Lockwood-Foster Electric Co., N. Y	100,000

Lumley Electric Light & Power Supply Co., N. Y	$ 250,000
Maine Electric Lt. & Storage Co., N. Y	2,000,000
Massachusetts El. Lt. Co., N. Y	500,000
Metropolitan Electric Lt. & Power Co. of the U. S	150,000
Metropolitan Electric Lt. & Power Co. of the State of N. Y	300,000
Magie Telephone Co., N. Y	5,000,000
Magneto Telegraph Co., N. Y	5,000,000
Manhattan El. Cable Co., N. Y	1,000,000
" " Co	250,000
" " Supply Co., N. Y	10,000
Maracaibo El. Lt. Co., N. Y., Ltd	100,000
Marvin El. Drill Co., Syracuse	300,000
Mutual Electric Light & Supply Co	500,000
Mutual El. Protective Assn'n, N. Y	60,000
Manhattan Electric Power Co	100,000
Metropolitan Electric Light Co	200,000
Markland Electric Light & Power Co	600,000
Mason-Wood Electrical Mfg. Co., N. Y	100,000
Merchants' El. Lt. & Power Co., N. Y	200,000
Metropolitan El. Storage Co., N. Y	25,000
" " Service Co., Rye	100,000
" " Signal Co., N. Y	1,500,000
Mexico El. Co	20,000
Microphone Battery Co., N. Y	5,000
" Carbon Battery Co., N. Y	25,000
Moffatt El. Const. Co., N Y	100,000
Mott Electro Motor Co., N. Y	1,000,000
Mutual El. Mfg. Co., N. Y	100,000
" Accumulator Co., Bklyn	50,000
Mc Leod El. Mfg. Co., N. Y	3,000
Mason El. Co., N. Y	25,000
Mercantile El. Co., N. Y	5,000
Met. El. Equipment Co., N. Y	20,000
Molyneux El. Mfg. Co., Buffalo	30,000
Moone Electrical Co., N. Y	50,000
Multiphase Motor Co., N. Y	200,000
Monarch Electric Co., N. Y	200,000
Mutual Electric Lt. & Mfg. Co	1,000,000
N. Y. Electrical Clock & Signal Co	500,000
N. Y. Electro-Magnetic Brass Co	10,000,000
Natl. U. G. Electric Co. of the City of N. Y	2,500,000
New England Electric Storage Co., N. Y	2,000,000
N. Y. Electrical Ozone Co	1,000,000
N. Y. Electric Co	10.000
Natl. Storage Cable Co., Troy	5,000
N. Y. El. Equipment Co	200,000
" " Wks	50,000
" " Engineering Co	10,000
" " Motor & Ventilator Co	30,000
Natl. Conduit Mfg. Co., Hastings	250,000
" El. Protector Co., N. Y	500,000
" " Co., N. Y	250,000
" " Service Co., N.Y	1,000,000
" " Const. Co., N. Y., Ltd	20,000
" Galvanic Battery Co	1,000,000
" Safety Lt. Heat & Power Co., N. Y	5,000
" Transportation Motor Co., N. Y	5,000,000
" El. Machine Co., N. Y	20,000
" " Mfg. & Const. Co., Troy, N. Y	50,000
Neutral Storage Battery & Power Co., N. Y.	200,000
New Am. El. Arc Lt. Co., N. Y	1,000,000
No. Am. Telephone Co., N. Y	1,000,000
" " U. S. Telegraph & El. Co., N. Y	2,500,000
" " " " " El. Co	5,000,000
" " El. Seal Unhairing Co., N. Y	10,000
New York Auto-Telegraph Co	2,000,000
N. Y. El. Time Co	300,000
National Electric Light Co	1,000
New York Electric Light Co	5,000,000
National Electric Light & Power Co	300,000
N Y. Electric Light Association	300,000
New Electric Light Co	100,000
N. Y. Isolated Accumulator Co	250,000
" Safety Lt. Heat & Power Co., N. Y	250,000
" Novelty Co	200,000
" Mail Box Co	50,000
" Const. Co	50,000

N. Y Equipment Co	$ 10,000
" Eureka Telephone Co., N. Y., Ltd	150,000
" El. Mfg. Co	100,000
" " Exchange	1,000
Ohmart Homans El. Ltg. Co., N. Y	750,000
O'Keenan El. Mfg. Co	100,000
Olmsted El. Lt. & Power Co	1,000,000
Pan-Electric Telegraph	5,000,000
People's District El. Lt. Co., Brooklyn, Ltd.	225,000
" " " " " Binghamton	50,000
Perkins Electric Lt. Co., N. Y	600,000
Phœnix Electric Co. for Canada	350,000
" " " of N. Y	350,000
Piedmont Electric Illtg. Co., N. Y	70,000
Panama El. Lt. Co., N. Y	200,000
Pennock U. G. Conduit & Surface Telegraph Co., N. Y	100,000
People's El. Time Co., N. Y	100,000
Phœnix El. Lt. & Power Co., N.Y. & Bklyn.	500,000
Planet El. Conductor Co	50,000
Popular El. Bell & Alarm Co., N. Y	25,000
Poff Compressed Air & El. Power Co., N. Y.	1,000,000
Porter El. Messenger Co., N. Y	200,000
Primary El. Co., N. Y	240,000
Pulsion Telephone Co. of N. Y	1,000,000
Pexnaux El. Co., N. Y	2,000
Proctor-Raymond El. Co., Rochester	30,000
Pulsion Telephone Co. of West N. Y., Buf	50,000
Remington Electric Lt. Co., N. Y	500,000
Richtor Electric Lt. Co., N. Y	500,000
Rogers Tel. & Tel. Co	5,000,000
" Telephone Co	1,000,000
Railway Tel. & Tel. Co., N. Y	1,000,000
" El. Time Co	500,000
" Audible El. Signal Co	10,000
Roberts Battery Lt. & Power Co., N. Y	5,000
Roberts-Brevoort El. Co., N. Y., Ltd	100,000
Rome El. Protective Co., N. Y	100,000
Rochester Electric Light Co	100,000
Saratoga Electric Illuminating Co	50,000
Standard Electric Light Co	1,000,000
Spanish Am. Lt. & Power Co., N. Y	2,000,000
Safety El. Power Co., N. Y	600,000
" " Lt. & Power Co., N. Y	250,000
Safety Ins. Wire & Cable Co., N. Y	500,000
" El. Lt. & Power Co., N. Y	3,000,000
Sawyer-Man El. Co	125,000
Seibold Electroid Mfg. Co., N. Y	100,000
Sachs El. Co., N. Y	20,000
Scott El. Lamp Co	25,000
Slocum El. Co., N. Y	50,000
Smith-Vassar Telephone Co., N. Y	1,000,000
Sheriden El. Lt. Co. of N. Y	500,000
Sims El. Torpedo Co., N. Y	1,000,000
Slattery Incan. Lamp Co	200,000
Smith & Rhodes El. Co., N. Y	10,000
Solar Arc Lamp Co., N. Y	25,000
Solar El. Co., N. Y	100,000
Southwestern Tel. & Tel. Co	3,000,000
Spalding Telegraph Co	1,000
Special Fire Alarm El. Signal Co., N. Y	50,000
Syracuse Storage Battery Co	300,000
Shaver-Anglo-Am. Telephone Co	60,000
Sims-Edison El. Torpedo Co., N. Y	1,000,000
Southern Holmes El. Protective Co., N. Y	500,000
" Telegraph & Cable Co., N. Y	100,000
Spanish Am. Lt. & Power Co., Consolidated, N. Y	4,000,000
Sprague El. Ry. & Motor Co., N. Y	1,600,000
Standard Telegraph & Conduit Co., N. Y	2,500,000
Sunderland Telegraph Co., N. Y	30,000
Solenoid El. Co., N. Y	500,000
Solar Lt. Co., N. Y	1,000,000
So. States El. Storage Co., N. Y	2,000,000
" El. Lt. Co., N. Y	500,000
Standard El. Mfg. Co., N. Y	60,000
Swan Incan. El. Lt. Co., N. Y	$ 800,000
Standard El. Co., N. Y	500,000
" " Subway Co., N. Y	250,000
Taylor Telegraph Co., Buffalo	20,000
Telemene El. Mfg. Co., N. Y	75,000
Telephone Const. Co	30,000
Tesla El. Co	300,000
Thermo El. Battery Co., N. Y	30,000
Troy El. Dynamo Co	20,000
T. P. Lipple Co	100,000
Thompson-Brown El. Co., N Y	25,000
Tilman Portable El. Lt. & Reflector Co., N. Y	100,000
U. S. Electric Lines Conduit Co., N. Y	500,000
" " Co., N. Y	25,000
" Electrical Co., N. Y	500,000
U. S. Wire & Cable Co., Schenectady	1,000,000
Universal El. Tunnel Co., N. Y	25,000
" " Pull Socket & Switch Co	20,000
U. S. El. Lighting Co	1,500,000
" Illuminating Co	1,000,000
United Globe Electric Light Co	6,000,000
The U. S. Electric Engine Co	1,000,000
Universal Electric Light Co	10,000,000
U. S. El. Ltg. Co	2,000.000
United Edison Mfg. Co	1,000,000
Universal Arc Lamp Co., N. Y	100,000
Van Choate El. Lt. Co., N. Y	5,000,000
Vibratory El. Motor Co., N. Y	1,000,000
Vance El. Co	10,000
Van Dirweyde El. Co	20,000
Wallace El. Tel. Mfg. Co., N. Y	1,000,000
Western States El. Storage, N. Y	2 000,000
Walcott Electrical Co., N. Y	500,000
Wurtz Fuel Gas & El. Lt. Co., N. Y	1,000,000
Wilson Bates El. Co., N. Y	1.500
Waddell-Entz El. Co	150,000
Walenn Electro-Depository Co., N. Y	1 000,000
Wenstrom No. El. Co., N. Y	125,000
West Side El. Mfg. Co., N. Y	12,000
Western Telegraph Const. Co	10.000
" N. Y. Mutual Tel. & Tel. Co	1,000
Weston El. Light Company	200,000
Wheaton Sub. El. Conduit Co., N. Y	1,500,000
N. Y. Appelgate El. Matting Co	1,000,000
Ampere El. Co	100,000
Fitch Electric Light Co	100,000
Excelsior El. Co	482.500
Central American El. Lt. Co	300,000
New England El. Storage Co	2,000,000
Star El. Lt. & Power Co. of the U. S	300,000
Schuyler El. Lt. Co	1,000,000
Marine El. Lt. & Storage Co	2,000,000
Empire Stale El. Lt. & Storage Co	100,000
New York & Brooklyn El. Lt. Co	25,000
Schuyler Foreign El. Lt. Co	1,000,000
Edison Spanish Colonial Co	100,000
Light & Force Co	5,000,000
Brush-Swan El. Lt. Co	2,000,000
N. Y. & Chicago El. Underground Co	2,500,000
Parker El. Mfg. Co	40,000
Binghamton Magneto El. Lt. & Power Co	50,000
Burrows-Hyde Underground El. Cable Co	100,000
Domestic El. Lt. & Power Co	1,200,000
Electric Const. & Supply Co	120,000
N. Y. El. Conduit Developing Co	500,000
Michigan Iron Wks. Lt. & Power Co	100.000
Paulett El. Steering Co. of N. Y	500,000
Reversible Hydrostatic Motor Co	600,000
Schuyler Foreign El. Lt. Co	1,000,000
Argentine Edison Lt. Co	500,000
Automatic Current & Protector & El. Mfg. Co	2,500,000
Buffalo El. Wks	50,000
Total	411,854 500

LIMITS AND POSSIBILITIES OF THE GAS ENGINE.

By George Richmond.

THE success of the gas engine, of which at least fifty thousand must be in use at the present day, has not been due to its superior efficiency as a means of transforming heat into work. Availability, and convenience in use, as compared with steam, have been the chief factors in determining its adoption. The recent construction of gas engines of large power—300, 400, or even 600 horse power—and the reports of performances which the steam engine cannot hope to equal, and the possibility of still greater efficiency, have combined to force attention to the claims of the gas engine as a rival of the steam engine in its own domain. A fairly-constructed gas engine of moderate, or even small, dimensions will convert into work eighteen to twenty per cent. of the heat supplied to it. This is not only very much better than the performance of any steam engine of comparable size, but superior to that of the more elaborate triple-expansion engine.

The following table gives some of the best results on record for the steam engine.*

The most sanguine engineer hardly expects to obtain any serious

Type of engine.	Absolute boiler pressure lbs per sq. in.	Steam used per hour per I. H. P. lbs	Percentage of W realized.	Thermodynamic efficiency.
Single-cyl. beam pumping engine (Mair-Rumbley)	59	21.3	46	0.11
Single-cyl. Corliss engine (Hill)	111	19.4	44	0.12
Single-cyl. Sulzer engine (Linde)	105	19.0	45	0.12
Two-cyl. compound beam pumping engine (Mair-Rumbley)	76	14.8	63	0.15
Two-cyl. compound Worthington "High Duty" pumping engine (Unwin)	75 90	17.7 17.4	53 51	0.13 0.13
Two-cyl. compound pumping engine (Leavitt). (Mean of two trials)	114	14.05	60	0.16
Two-cyl. compound high speed single-acting engine (Willans)	180 (about)	14.26	54	0.16
Triple marine engine of S. S. "Iona" (Kennedy)	180	13.35	58	0.17
Triple experimental engine (Reynolds)	207	12.68	59	0.18
Triple high speed single-acting engine (Willans)	190 (about)	12.74	60	0.18
Triple Sulzer engine (Schroter)	171	12.2	64	0.19

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* "The Steam Engine and Other Heat Engines," Ewing.

improvement on the best results now recorded for the steam engine. A little less than eleven pounds of steam and a little more than one pound of coal to the horse power is apparently the ultimate limit of steam-engine economy. On the other hand, gas engines using "producer" gas regularly yield one horse power to about seven-eighths of a pound of coal. In both cases the figures are in terms of indicated horse power, but the mechanical efficiency of the gas engine is about the same as that of the compound or triple-expansion engine.

There are probably few industries in which the cost of power bears so large a ratio to the total expense that one-eighth of a pound of coal per horse power would in itself have much weight in determining the choice. Nevertheless, the gas engine, having established its claim to consideration, could, and undoubtedly will, be adopted in many cases with great advantage, in preference to steam power. For it must be remembered that the present claim of the gas engine is not simply that it is well adapted to special applications; all this has been conceded,—with a certain patronizing condescension, it is true. The advocate of the gas engine no longer pleads extenuating circumstances, but boldly claims recognition on an equal footing with steam. This confidence is based partly on accomplished facts, but largely on expectations of greatly-increased efficiency. As to the maximum efficiency to be obtained in practice the doctors differ; a conservative writer puts it at forty per cent.; a more hopeful one proposes a plan by which upward of seventy per cent. of the heat supplied is expected to be turned into work. This would mean less than half a pound of coal in the one case, and about a quarter of a pound in the other, for one horse power per hour; should either of these efficiencies be realized, the fate of the steam engine would be sealed.

The operation of a gas engine of the ordinary four-stroke type is too well understood to need description, but it may be pointed out that its action and theory do not differ essentially from those of the steam engine. We may consider that air, instead of water, is pumped into the boiler, and that each cylinder charge is heated on its way (after being shut off from the boiler) to the temperature it acquires by combustion in the cylinder. We perceive at once an obvious advantage in performing the combustion actually within the cylinder, since the loss of heat in the chimney is eliminated.

It is usual to refer all heat engines to the perfect heat engine imagined by Carnot, in which the efficiency depends only on the initial and final temperatures being very simply expressed by the fraction:

$$\frac{\text{Temperature of Supply}-\text{Temperature of Rejection}}{\text{Temperature of Supply.}}$$

This in many cases is extremely misleading, and justifies suppositions very far from the truth. As a matter of fact, it is very easy to determine, for any given heat engine employing in a given cycle an agent whose physical properties are known, the precise amount of heat that can possibly be converted into work under the given conditions. The ratio of this to the total heat supplied is the highest efficiency obtainable, and the only one with which we have any practical concern, except when the relative advantage of different agents is in question.

This question, which is usually ignored in the loose application of the Carnot ratio $\frac{T^1 - T^2}{T_1}$ to the ordinary gas engine, is precisely the most important in the present connection. A gas engine working on the "Otto" cycle could not possibly utilize as much heat (barely half as much) as a steam engine working between the same temperatures, and the current statements that the gas engine utilizes a much smaller proportion of the available heat than the steam engine are greatly exaggerated. Failure to recognize this fact not only raises expectations which can never be realized, but diverts the mind from the fact that an approach to the ideal efficiency can be realized only by a radical departure from the "Otto" cycle; if this is not practicable, then we must be content with a moderate improvement in the efficiency of the gas engine. For example, the statement that the gas engine is capable of converting into work seventy or eighty per cent. of the heat supplied to it is not true as applied to the gas engine, as we are acquainted with it. The "Otto" cycle is now so universally adopted that no other is ever suggested by the term gas engine. Now, as this engine is usually run, the heat available for transformation into work does not amount to more than thirty-four or thirty-six per cent. of the heat supplied. Therefore *an ordinary gas engine will compare favorably with the best compound or triple-expansion engine in both thermal and mechanical efficiency.*

In the above table the third column gives the percentage of available heat actually converted into work. The available heat in this case is not that of an ideal cycle between highest and lowest temperatures, but that of the actual steam engine cycle. Now, a gas engine converting twenty out of thirty-four per cent. of available heat realizes about sixty per cent., which is higher than the average realization of the steam engines in the table. The corollary to this is that the present gas engine is susceptible of only very slight improvement in efficiency Theoretically the efficiency could be increased almost indefinitely by increasing the compression, and one plan contemplates at least ninety atmospheres. On this point an expert entitled to the most respectful attention writes as follows: *

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* The Gas Engine," Dugald Clerk. J. Wiley & Sons.

"Can this principle be much further extended in its application?" In the author's opinion, no. By undue increase of compression the negative work of the engine would be much increased, and the strains would become so great that heavier and more bulky engines would be required for any given power. Friction due to this increases more rapidly than efficiency; consequently the gain in indicated efficiency would be more than compensated by loss of effective power.

One means of improving the cycle itself has received a great deal of attention from inventors; in fact, nearly every maker of gas engines has tried to utilize it. The circumstance that in the gas engine the burnt gases are allowed to escape at a pressure much above that of the atmosphere never fails to impress the casual observer. To him compression seems an evil,—necessary perhaps,—but complete expansion appeals so strongly to his imagination that he is astonished that no one, prior to himself, has thought of such an obvious opportunity of improving the efficiency. Many ingenious schemes for realizing this modification of the "Otto" cycle have failed; their failure hitherto has been chiefly due to the fact that it involves a great increase in the volume of the cylinder for a given power. A consideration of the fact that, for a given volume of piston displacement, the *amount* of heat involved is very different in the two cases will indicate the reason why methods suitable for the steam engine are entirely inapplicable to the gas engine.

At a pressure of 45 lbs. one cubic foot of steam contains 130 thermal units, while a cubic foot of air at 45 lbs. pressure and 740 deg. (the absolute temperature of the exhaust usual in practice) contains only 13 thermal units. From this it is obvious that the losses incidental to compounding, which would be insignificant in the case of steam, would be absolutely fatal in the case of the gas engine. The most promising attempt to utilize more complete expansion was that of the Atkinson engine; but notwithstanding the fact that compounding took place within one single cylinder and with great rapidity, the gain was insignificant, and, taking into account the increase of available energy, the thermal efficiency of the engine was reduced.

If we are thus cut off from improvement whether by increasing the compression or by increasing the expansion, the conclusion is inevitable that the gas engine is as near to its final efficiency as the steam engine. There would seem, however, to be more chance of success in the line of increased compression, the difficulties in this case being chiefly mechanical, and not, as in the other case, physical. An extreme application of this principle was planned by Herr Diesel.*

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* "Theory and Construction of a Rational Heat Motor." R. Diesel Translated by Bryan Donkin Spon

The extreme diversity of views and emphatic statement of them current might be moderated by a clearer apprehension of the principles involved, it is equally pertinent to remark that the flippant charge of incompetency made against gas engineers is entirely unwarranted. A steam engineer can design a steam engine on any given lines, and predict very closely the result ; a corresponding prediction for a gas engine departing from known and tried conditions is a sign, not of knowledge of the subject, but of ignorance of its complexity. The final result to be achieved may be perfectly definite, but experience shows that it can be approached only by tentative balancing of conflicting conditions. The theory of the gas engine, as of any other heat engine, is really very simple, and, in view of the necessity of keeping them in mind in this connection, an attempt has been made in the appendix to this paper to present the leading facts as free from technicalities as possible. It may be perfectly true, as asserted, that the art is very much further advanced in Europe than in America. Nevertheless, the importance of the gas engine of large power, as a possible rival to the steam engine, is receiving recognition. It is said that the Westinghouse Company is preparing a gas engine which is to be an advance upon those at present in use. The information has come to the public in the interview form, with characteristic vagueness as to detail ; confidence, however, is inspired by the fact that the performance (three-quarters of a pound of coal to the horse power) claimed is well within possible limits. The De La Vergne Refrigerating Machine Company, which has created a special department for the manufacture of oil engines, has for several years been collecting data and studying the subject of gas engines of large power, and is understood to be prepared to put them on the market, should their investigation lead to any substantial improvement on existing types. Others are doubtless working at the same problem, and it is satisfactory to know that the interests of the gas engine are in the hands of firms capable of intelligent, and, above all, sustained, effort ; nor is there any reason to fear that America will be left behind in this industry.

Oil engines (which constitute another special form of the hot-air engine) are apparently destined to supplant of both gas engines and steam for moderate power. They have all the advantages of the gas engine, with the additional advantages of costing considerably less to run and being available in situations where gas cannot be obtained. The gasoline engine has enjoyed an ephemeral popularity, and will probably still continue in use where neither gas or oil has been made available. This is notably the case in the so-called "horseless carriage," or automobile,—the application at present most in evidence.

The difficulties in this case are complex, and about equally divided between the motor and the transmission mechanism. The partial mechanical success obtained in Europe has created a craze for this class of vehicle. At present the inventors are exhausting all the possible ways of "how not to do it." Nevertheless, to the careful observer some of the most pronounced failures are more suggestive than the most correct designs. The name "horseless carriage" while it correctly represents the sphere of present activity also indicates wherein the same is at fault. No really successful self-propelling vehicle will be produced until not only the horse but the carriage builder is eliminated. The Pullman car is not a horseless stage coach, and the motor vehicle of the future will not be a horseless carriage.

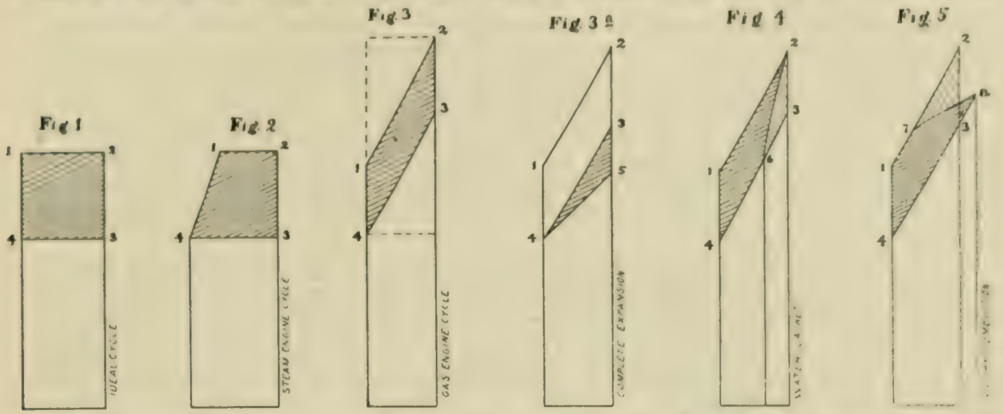
As regards the motor, no new principle is likely to be evolved, while we may expect many novelties in the way of mechanical construction. When the machine proper is lightened to the greatest possible extent, there still remains the necessity of carrying water for the cylinder. One horse power means the turning of heat into work at the rate of about forty-three thermal units per minute. The heat passing into the jacket is about two and one-half times this, or, say, one hundred thermal units per minute. If a three or four horse power motor is used, there is more heat than can be gotten rid of by conduction in any air-cooling device of reasonable dimensions, and a considerable weight of water must be carried, boiled away, and renewed.

One inventor boldly "denies the allegation and defies the alligator," and also explains. The first explanation was that the motor, by virtue of using liquid gasoline, was a refrigerating machine in combination with an engine. As the latent heat of gasoline is about one per cent. of the heat of combustion, this explanation is clearly inadequate. The second explanation is a double spark, the first cooling and "ripening" the mixture, while the second ignites it.

The interest in this explanation is confined to the treatment of it in the technical press, as indicating the extent to which the principles of thermodynamics are or are not accepted, as the case may be. If one is willing to sacrifice the efficiency, it is easy to see how, in accordance with well-known principles, a large portion of the jacket heat may be thrown into the exhaust. The mean temperature of the cylinder must be maintained within moderate limits. Now, the initial temperature may be reduced by working with a very weak mixture, which results in delayed combustion, and the final temperature may be reduced by increasing expansion, the simplest and crudest method of obtaining which is to choke the suction. For further reduction of the mean cylinder temperature add misfires in sufficient quantity.

APPENDIX.

If the quantity of heat supplied to an engine be represented by a rectangle whose height is equal to the absolute temperature (on any convenient scale) at which the heat is supplied, then this may be divided into two parts by a horizontal line drawn at the temperature at which the heat is rejected (Fig 1). The ratio of the part cut off from the line to the whole line is evidently $\frac{T^1-T^2}{T^2}$, and the rectangles on these lines represent respectively the heat transformed into work and the total heat. Moreover, following the shaded rectangle around is equivalent to reading off the physical changes of the agent. Taking steam, for example, and commencing at the corner marked 1. From 1 to 2, heat is added without increase of temperature (water evaporated at temperature T′). From 2 to 3, the temperature is reduced without addition or removal of heat (adiabatic expansion). From 3 to 4, heat is removed without change of temperature (condensation). From 4 to 1, temperature is realized without addition or removal of heat (adiabatic compression). This is the ideal cycle, and that of the ordinary steam engine differs from it mainly in the fact that hot water at temperature T′ is not produced by compression of partially-condensed steam, but by application of heat at constant pressure in the boiler. The rise in temperature, then, from 4 to 1 is accompanied by a progressive addition of heat, and the line bends to the right, as in Figure 2. The ratio of the shaded portion to the whole area is less than in the previous case, and this new ratio is the highest efficiency obtainable with the ordinary steam engine. A consideration of these figures will explode a popular fallacy, which dies hard,—namely, that latent heat is a great drawback to the use of steam as an agent. It is obvious that, the greater the latent heat of the agent, the nearer the practical cycle of Fig. 2 approaches the ideal cycle of Fig. 1.



1—Ideal Carnot Cycle. 2—Steam Engine Cycle. 3—Otto Gas Engine Cycle. 3*a*—Ditto with Complete Expansion. 4—Ditto with Water Jacket. 5—Effect of Delayed Combustion (Nachbrennen).

In the case of the gas engine on the "Otto" cycle the highest temperature is reached partly by compression and partly by the addition of heat by combustion at constant volume. In Fig. 3 compression raises the temperature from 4 to 1; and 1 to 2 marks the rise in temperature in consequence of the addition of heat, the amount of which is represented by the area swept out by the vertical line in travelling from 1 to 2. Since the specific heat of air at constant volume is only .169, this line, 1-2, is very much steeper than in the case of heating of water. From 2 to 3, the temperature of the air is reduced without addition or removal of heat (adiabatic expansion). The expansion is continued until the initial volume is reached, or the point 3 lies upon a line of equal volume drawn through 4. The shaded area, as in the previous case, represents the total amount of heat which it is possible to convert into work in the "Otto" cycle. If we draw a horizontal line through the points 2 to 4, we obtain the rectangle representing the available heat for an ideal engine working between the same temperature 2 and 4. The difference between these areas indicates very clearly the absurdity of applying the Carnot ratio to the "Otto" gas engine. All the facts and possibilities of this cycle can be read at a glance from this figure. It is obvious that the efficiency is proportional, not to difference between the highest and lowest temperatures, 2 and 4, but to the difference between the temperatures produced by compression and the initial temperature 4. From this it follows that the efficiency of the theoretical "Otto" cycle can be increased to any desired degree by increasing the compression. It does not, of course, follow that this would be true in actual practice.

The gain by complete expansion is seen in Fig. 3. The expansion, instead of stopping at the point 3, is continued till the atmospheric pressure is reached (Fig. 3*a*). At the point 4 the gas is at atmospheric pressure, and a line of equal pressure drawn through this point will be less steep than the line 4-3, since the specific heat of air at constant pressure is greater than at constant volume. This line will cut the vertical, 2-3, at the point 5, and the additional work obtained by complete expansion is that represented by the triangle, 4–3–5 Not only is the available heat of the gas engine much less than that of the ideal engine of similar range, but it is further diminished by two circumstances,—the one physical and easily understood, the other chemical and somewhat obscure. The temperature obtaining in the gas engine would make the cylinder nearly or quite red-hot, and render proper lubrication impossible. Hence the necessity of the water jacket, which carries away nearly one-half of the total heat supplied to the engine. This involves a great sacrifice of the available energy, but if the water jacket were suppressed the greater part of the heat it eliminates would go into the exhaust.

The action of the water jacket may be seen in Figure 4. During expansion heat is removed to an amount represented by the area swept out by the vertical in travelling to the left from 2 to 6. The area of available energy is diminished by the triangle, 2–3–6, and the exhaust heat is diminished by the area swept out by travelling from 3 to 6. This latter quantity of heat belongs to the exhaust or rejected heat, and it is immaterial whether it passes out in the jacket or the exhaust.

The sum of these two does not represent the fifty per cent. of jacket heat, for a large part of this is taken up during the exhaust stroke. The point 6 can be determined when the final temperature or pressure of expansion is known, and the two areas in question would be ascertained with sufficient accuracy by drawing a straight line from 2 to 6. On the indicator diagram this represents an expansion line considerably below the adiabatic curve. But the second circumstance has an opposite effect, and the combination of the two generally results in throwing the actual expansion line above the adiabatic. The reference here is to retarded combustion, or the celebrated "Nach-Brennung." It is found that at the moment of ignition the theoretical temperature 2 of Fig. 3 is not obtained, and consequently only the heat due to partial combustion is applied along the line, 4–2, the remainder being added during the expansion. Fig. 5 represents this phenomenon; the first ignition supplies heat from 1 to 7, and the expansion line is carried out of the vertical, over to 8, by the subsequent addition of heat. If the area by the path 1–7–8 (Fig. 5) is the same as that from 1 to 2 (Fig. 3), the combustion is completed at the end of the stroke. If it is less, then unconsumed gas is passed out with the exhaust. The positions of both the points 7 and 8 depend on a variety of circumstances, the most important being the proportion of gas to air at the time of ignition. Each of the circumstances indicated by Figs. 4 and 5, taken alone, represents a thermodynamic loss, but their combination and superposition would not therefore necessarily result in a practical loss,—might even result in gain.

The "Sterling" hot-air engine follows very closely the "Carnot" cycle, and there is no great difficulty in making the ordinary gas engine follow the same cycle. We have seen that the quality of steam which causes its practical cycle to approximate closely to the ideal cycle is its large latent heat. But latent heat, so called, is nothing more than heat transformed into work, largely molecular in the case of steam. In the gas engine, if the work is done at the rate of generation of the equivalent heat by combustion, we have an exactly corresponding condition. Moreover, we have become acquainted with concurrent combustion and transformation into work in the phenomenon of "Nach-Brennung." The line 7–8 in Fig 5 may become horizontal, and may easily be conceived to start at 1. It is merely a question of controlling the combustion and dilution.

Returning to our original Fig. 1 of the ideal cycle, suppose air (largely in excess of that required for complete combustion) and gas to be separately compressed to the temperature 1, assumed to be at least high enough for spontaneous combustion. If the air alone were let into the cylinder, it would be cooled by doing work against the piston. If sufficient gas to combine with the air were introduced, the temperature would instantly rise. But, if the gas is introduced in such quantities that the heat of combustion just balances the cooling of the expanding mixture, a constant temperature will be maintained, the heat supplied being equivalent to the work done. At 2 the supply of gas and air is cut off, and the temperature is reduced to 3 by adiabatic expansion. If at this stage it is compressed at constant temperature to 4, we have the complete Carnot cycle. This is substantially the cycle proposed by Herr Diesel.

RAILROAD ACCIDENT AND EMERGENCY SERVICE.

By W. L. Derr.

THE importance of opening a blockaded railroad line can best be appreciated by reflecting for a moment on the vast interests depending on the prompt movement of trains. Let us consider, for example, on any one of the lines running to New York city, transporting thousands of persons and hundreds of cars of freight daily, the great inconvenience to travelers, not to mention the losses to the railroad by delay and consequent damage to freight, caused by a few hours' blockade. Business matters disarranged by failure to reach one's destination at an appointed time or by inability to make deliveries of important freight; social affairs upset because of failure to arrive in time to participate in an important function.

Another consideration, and one whose consequences may be more far-reaching, is the blockade of a railroad engaged in handling troops and supplies in war operations. A few hours' delay in the delivery of troops or ammunition on a field of battle might be attended with the most disastrous results. There is no doubt that railroads will play an important part in the wars of the future, and a capable staff will find it necessary to watch the railroad wrecking force and equipment with the greatest care and to see that both the men and the tools are so placed as to be available at the shortest possible notice. In military operations a railroad wrecking outfit will be found almost indispensable in clearing the line for an advance movement or in blockading or destroying the line in a retreat.

First in importance in a wreck-train organization is the wrecking crew, the size of which depends largely on the work it has to perform. At a large wreck a force of from twenty to thirty men may sometimes be employed to advantage. It will usually be found, however, that a force of about sixteen men is sufficient to handle an ordinary wreck, if steam power is used in lifting. As in other lines of work, good discipline, which implies order and prompt obedience, is absolutely essential to success, and this can be commanded only through intelligent and properly-instructed workmen. The railroad wrecking force, often called upon individually to act and think promptly and correctly under extraordinary conditions, must be composed of men who are intelligent, well-informed in their business, and physically and mentally able to endure hardships which would, to say the least, deter the average man. Wrecking is not a business for nervous or rattle-headed men, and no man who has a fear for his personal safety, or is inclined to " lie down " at a critical moment, should be attached to a force having that work to do.

A knowledge of rigging and of other work connected with cordage is as essential to the wrecker as it is to the sailor. The wrecker must know how to splice a line, reeve a tackle, and tie the more common knots, such as the flat knot, bowline, two half-hitches and round turn, and timber hitch. He must know how to so care for ropes that they will at all times be in condition for use.

The wrecking foreman is usually a man who not only is familiar with his own class of work, but also has a general knowledge of the running of trains and the repair of track; who is ever ready to take advantage of the multiplicity of circumstances that may arise at any time, and capable of acting promptly, with clear head and firm hand, in difficult and dangerous situations. Men from the car-repair shops make the best wreckers. They work, in the course of their routine shop duties, with the very tools used at wrecks, and are therefore familiar with cranes, lifting jacks, tackle, levers, etc.

Some lines depend upon their trackmen to do the wrecking, but, owing to the difficulty of assembling them promptly,—the force usually being scattered over a considerable territory,—and to their lack of training in matters pertaining to such work, the practice cannot be commended. The same trackmen are seldom available the second time, so that there is not the chance of giving that class of workmen the training which this work calls for.

An important member of the wrecking crew is the cook. Wreckers seldom have time, after being ordered to a wreck, to get a supply of food at home to take with them ; hence it is necessary to at all times have provisions on hand in the living car, and some one in the crew able to prepare it. The excellent canned goods which can be obtained everywhere insure a variety of good, wholesome food, than which there is nothing more essential to the wrecker, exposed as he is to all kinds of weather, being often called on to ply his vocation in the most severe storms,—and in other respects working under the most unfavorable conditions. To sum up, the wrecker should be an all-around good man, capable of doing a variety of work, the manner of doing which must necessarily, in many instances, be left to his own ingenuity.

In addition to its regular wrecking work, the wrecking force may, to good advantage, be drilled in fire service work, including bucket and ladder practice ; and in this connection it is suggested that steam crane cars be provided with a fire pump, hose, and other appliances for extinguishing fires at wrecks or elsewhere. The steam crane is usually kept with a banked fire under its boiler, so that steam can be raised at a moment's notice, and there are always plenty of men around the shops who are able to handle a fire pump and other fire appliances, even when the regular wrecking force is not at hand. Thus is provided a good and well-equipped fire apparatus, available at nearly all times. The wrecking outfit is generally stationed at points where there are important and valuable shops, offices, stations, and other property peculiarly liable to destruction by fire. In many instances these buildings are inaccessible to the engines of the local fire departments, while most of them are reached by the railroad tracks, making them entirely accessible to the steam crane car. Further, this apparatus may be sent, in case of fire, to outlying points, for the protection of railroad property.

The first aim of the wreckers, on arriving at the scene of a wreck, is, after caring for injured persons, to open the line for traffic as quickly as possible. This has to be done at the further sacrifice, in many instances, of rolling stock and the coarser kinds of freight, especially in a district where there is a heavy passenger traffic. On double-track lines the track more easily cleared is the first opened, for, with one track cleared, traffic can be resumed by operating a single-track line past the obstruction. In an open country, on single-track lines, it is often found advantageous to build a temporary track around the wreck.

In picking up damaged freight the most perishable and expensive kinds receive earliest attention. Fresh meat, fruit, and other stuffs of a highly perishable nature are cared for first. As soon as possible, damaged cars containing meat and fruit are boarded up to exclude air from their interiors. Perishable freight is usually—meat always—carried in refrigerator cars, and it is of the utmost importance that the outside air be kept from contact with it. Prompt action in this respect is absolutely necessary to prevent great damage. When meat has to be transferred to other cars, refrigerator cars, cleaned and well iced, should, if possible, be provided for the transfer. Refrigerator cars are equipped with hooks overhead for holding meat. Meat should not, be placed on the car floors, except in case of necessity. When meat has to be transferred into other than refrigerator cars, the cars should first be well cleaned and swept, and scrubbed with clean water, and all holes in their bodies cleated to exclude air. The floors should then be covered with a layer of clean ice, in as large cakes as possible. If the meat cannot be hung up in the cars,—and usually it cannot,—clean planking should be laid on the ice to support it. The meat should not be placed directly on the ice. The men engaged in transferring meat should keep their hands clean, and cover their clothes with clean burlaps. Rubber gloves will be found useful in handling meat, and will contribute to cleanliness.

The care of injured persons is, of course, the first and most important consideration at a wreck. Naturally the first duty is to make the injured as comfortable as possible, not forgetting to have the nearest surgeon called. The following excellent suggestions for the care, by employees, of the injured, until the arrival of a surgeon, are recommended by an association of railway surgeons, and, being divested of technicalities, can easily be comprehended by the layman :

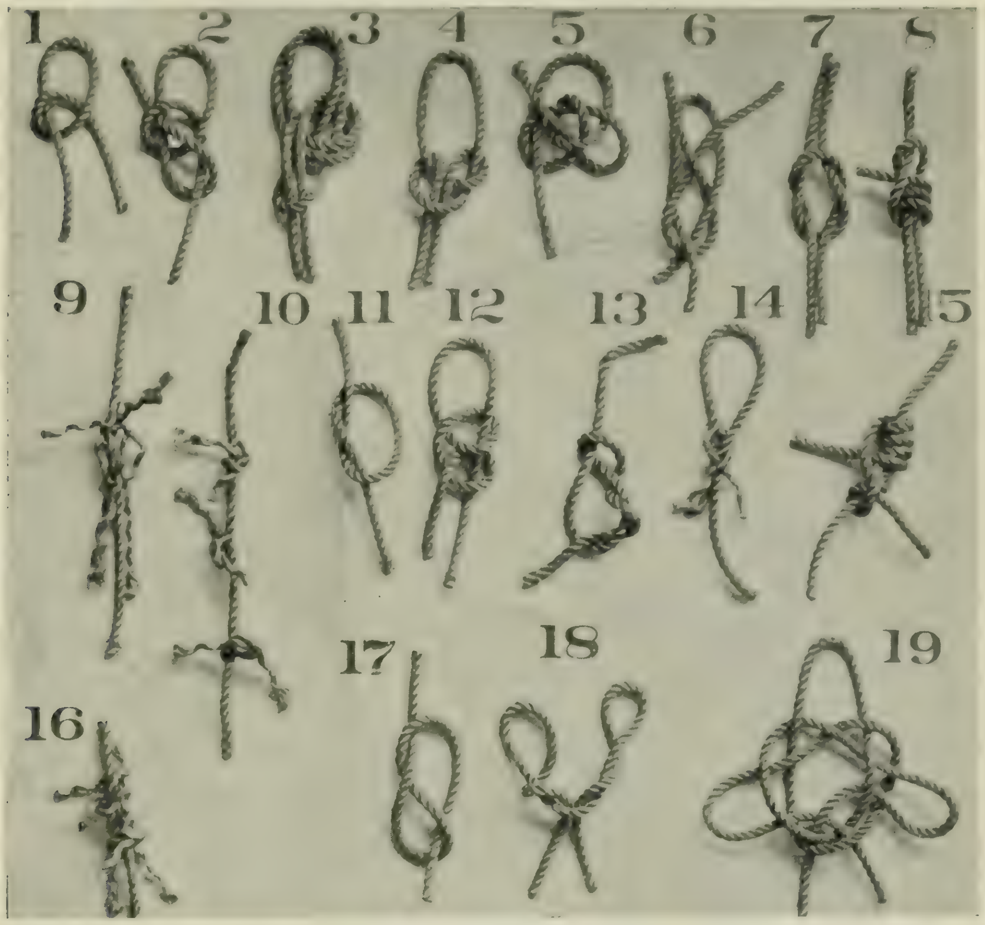
When a person is injured and bleeding freely, elevate the limb or part, if possible, and draw the edges of the wound together with the fingers. Apply a closely-folded handkerchief or cloth (the cleaner the better) directly to the wound, and make pressure with it, or, if the hemorrhage is violent, apply a snugly-drawn bandage or handkerchief to the compress over the wound. A tight bandage must not be kept on too long ; the blood vessels and nerves may be injured by continued hard pressure. Cloths rung out of hot water and applied to a bleeding surface are an excellent means of checking hemorrhage. Slight oozing of dark-colored blood requires no compression. Never apply tobacco quids or other filthy substances to a wound. They do no good whatever, and only delay the healing process by poisoning the wound.

When a person is suffering from shock after an accident, keep the head low,—on a level with the body,—so that the circulation of blood may easily continue to the brain. While moderate stimulation may be useful in cases of shock, excessive use of alcoholic liquors is injurious. If whiskey is used, do not give over two or three tablespoonfuls. Hot coffee is a valuable remedy at such a time,—more valuable than whiskey. Apply warmth to the body, and rub the hands and feet to keep the blood circulating.

In carrying or transferring injured persons, handle them carefully, keeping the injured parts in the most natural and comfortable positions that circumstances will permit. Always support a crushed or fractured limb.

The writer has found the common passenger-coaches better adapted to the transportation of seriously-injured persons than Pullman cars, whose winding entrances are not convenient for the passing through of the stretchers. Furthermore, the seats of the common coaches are easier to arrange for the reception of persons on stretchers, and allow of better positions for rendering immediate surgical aid.

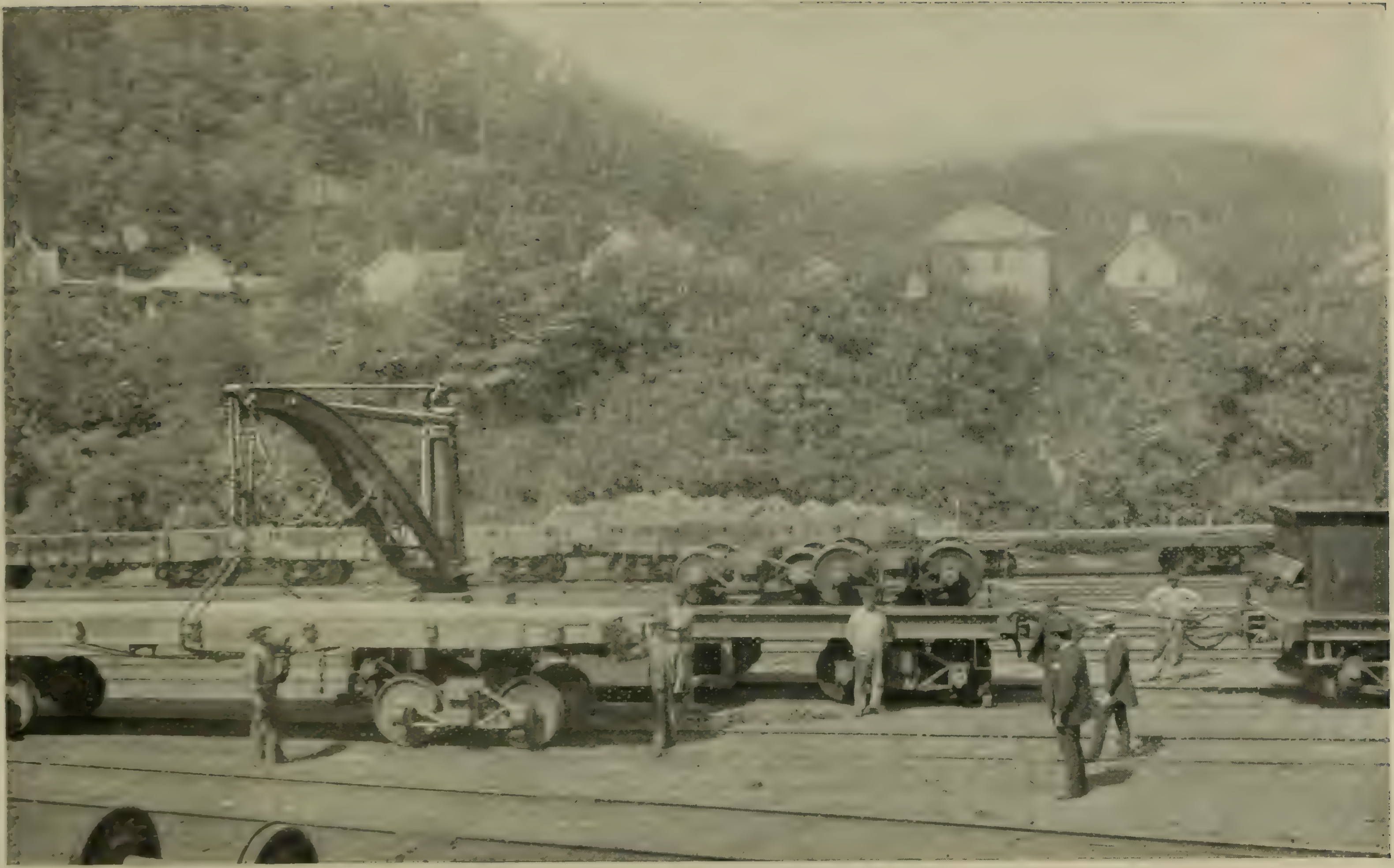
It is proper that wreckers and trainmen should be more or less familiar with such details, especially on lines running through thinly-settled districts, where considerable time is likely to elapse before surgical attention can be secured. Suffering can be relieved greatly by even a slight knowledge of surgical practice, and by gentleness on the part of those handling injured persons.



SOME KNOTS USED IN WRECKING.

1—Commencement of a bowline. 2—Single bowline. 3—Double bowline on a bight. 4—Single bowline on a bight. 5—Running bowline. 6—Double Garrick bend. 7—Flat knot. 8—Fisherman's bend. 9—Short splice. 10—Long splice. 11—Overhand knot. 12—Two half-hitches. 13—Timber hitch. 14—Eye spliced in end of line. 15—Stopper on line. 16—Shroud knot used for putting two lines together when end is short. 17—Figure 8. 18—Cats-paw. 19—Mast-head knot.

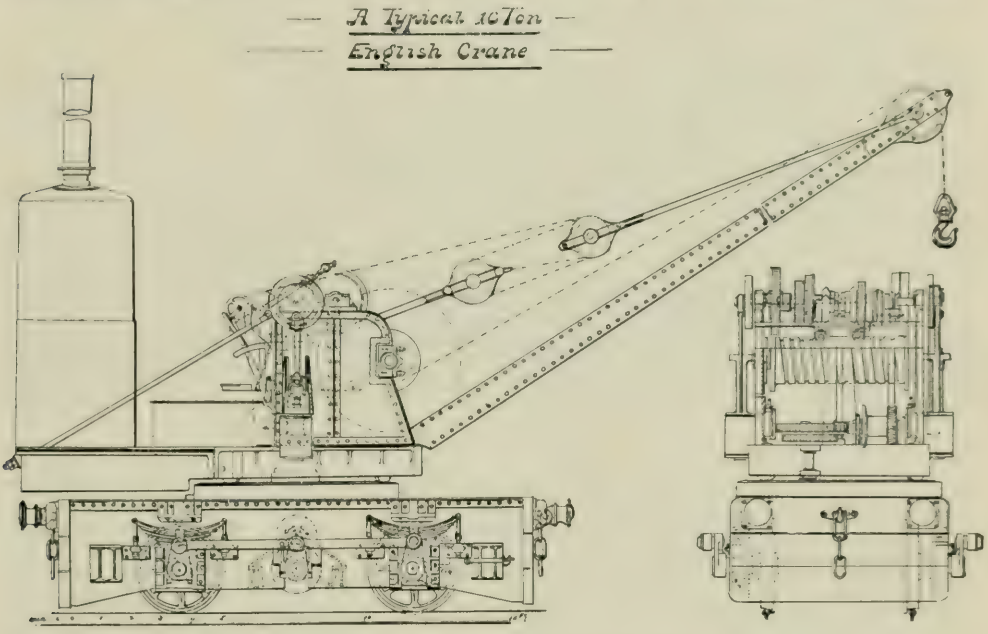
Most railroads maintain a surgical staff, whose members are scattered along the line at convenient points. The staff is usually composed of local physicians, who attend to the railroad cases in addition to their other practice. On some roads, especially in the west, there is a chief surgeon, who has general supervision of surgical matters. Hospital facilities are also often provided by railroads at division terminals, the roads owning the hospitals outright or being shareholders, or having contracts with the owners.



WRECKING DERRICK WITH LOCOMOTIVE HOIST.

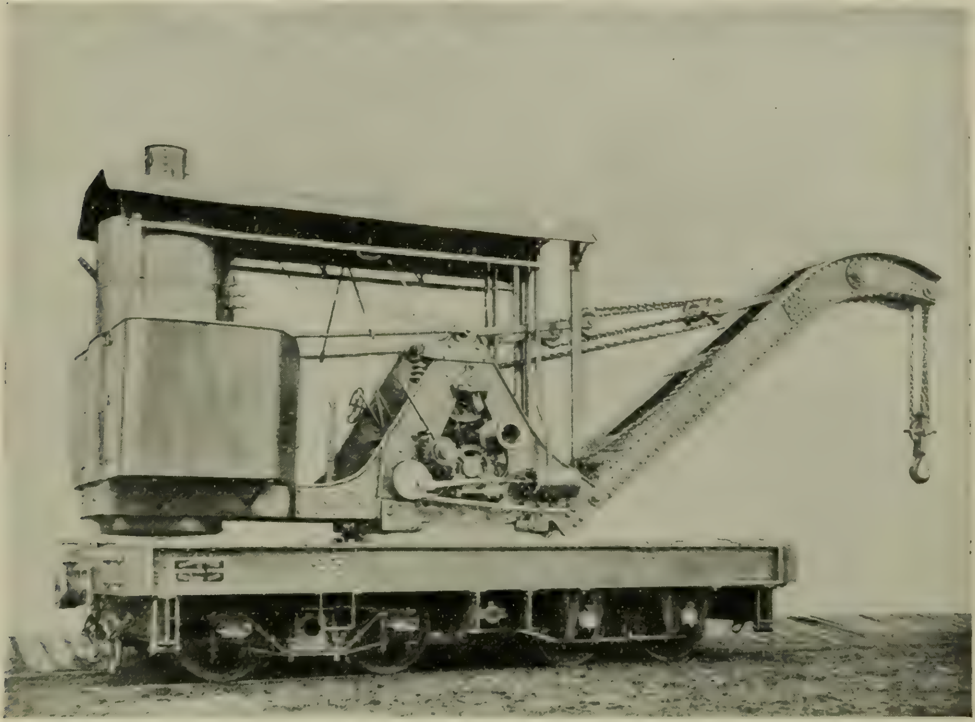
A wrecking train usually consists of the locomotive, one and perhaps two crane cars, a tool and living car, sometimes an additional tool car for carrying blocking and the coarser tools, and a caboose.

Of wrecking equipment, first in importance are the crane and its car. There are three kinds of cranes used in this service,—hand-power, locomotive-power, and steam-power by hoisting engine attached to the crane. On account of the great weight of locomotives and of cars, the steam crane is the most desirable. A crane, to be of service in all cases, should have a lifting capacity of at least twenty-five tons. The car itself, including the tracks, should be of iron or steel throughout. It should be very strongly built, and have both hand- and air-brake appliances. Besides the ordinary air-brake equipment, there should be an air pump operated by steam from the crane boiler, and an air reservoir to enable the air brakes to be operated on the wrecking train in the event of its being necessary to run the train with a locomotive not equipped with air brakes. The air may also be used to operate clutches, clamps, etc., on the crane. Modern crane cars are generally made self-propelling at low speeds. For anchoring the car when heavy side lifts are made, "outrigger" beams, their outer ends to rest on jacks, are provided, and so arranged that, when not in use, they can be stored under the car.



A TYPICAL 10-TON ENGLISH CRANE.

The crane should be of iron or steel, and the boom preferably of the plate girder type of construction, although rolled beams may be used with safety. The steam crane should be able to lift or lower its load without reversing its engines, and to revolve in either direction. After lifting a load to a certain height, it is generally necessary to swing it to one side; hence the necessity of revolving the crane while it is in the act of lifting. A set of levers is provided for manipulating the different movements of the crane. The levers are grouped so that the attendant can handle them all without changing his position. A further improvement in this line would be gained by arranging a lever for revolving the machine from the ground, when necessary, that being the best position for determining where the load should be swung. Following are the specifications of a well-known firm of builders, for the crane, engine, boiler, etc., of a 25-ton machine:

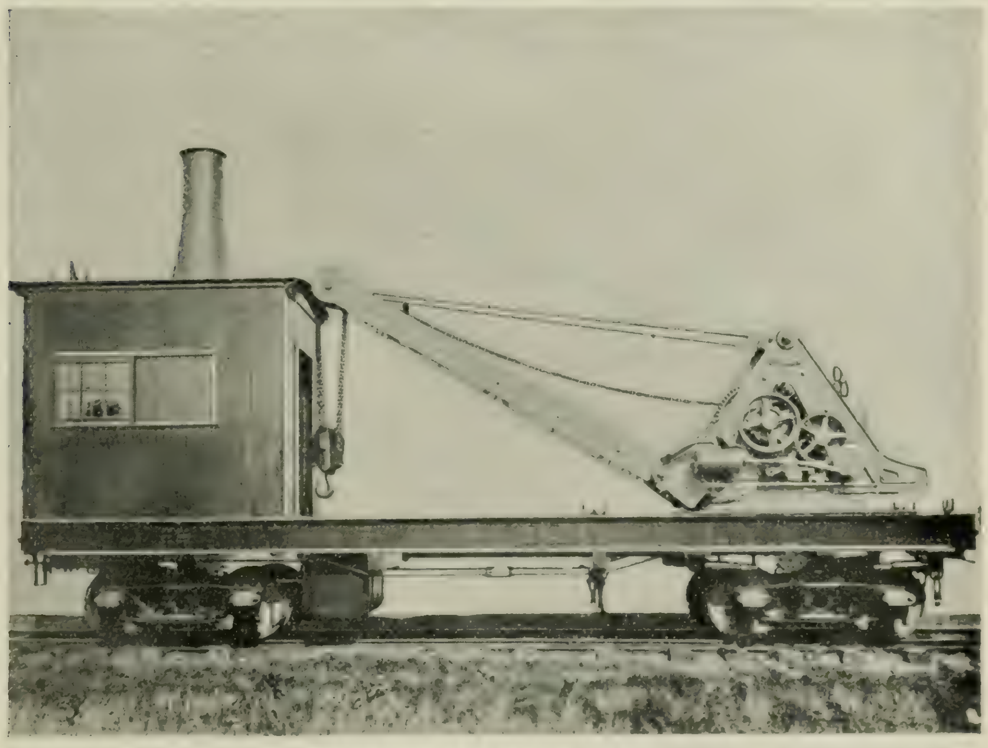


STEAM DERRICK.

The frames of the crane are of cast iron, and to them are secured the boxes for the shafts operating the mechanism for hoisting, traveling, and slewing. The bearings are of ample size, made of bronze for important journals in frame, and babbit for others, and the shafts are of forged iron and steel. The operation of hoisting is through a train of spur-gearing operating directly the hoisting drum. There are also provided suitable lowering and sustaining brakes. Slewing the crane in either direction is accomplished without reversing the engine, by a double clutch, and by a train of spur- and worm-gearing, the worm-gearing locking the crane in any position. The gearing is of cast steel or bronze throughout. The levers controlling the different motions are of forged iron, and so arranged as to work fore and aft. The jib is so curved that the extremity is horizontal when in position to operate at a radius of sixteen feet, and of sufficient strength to carry full load.

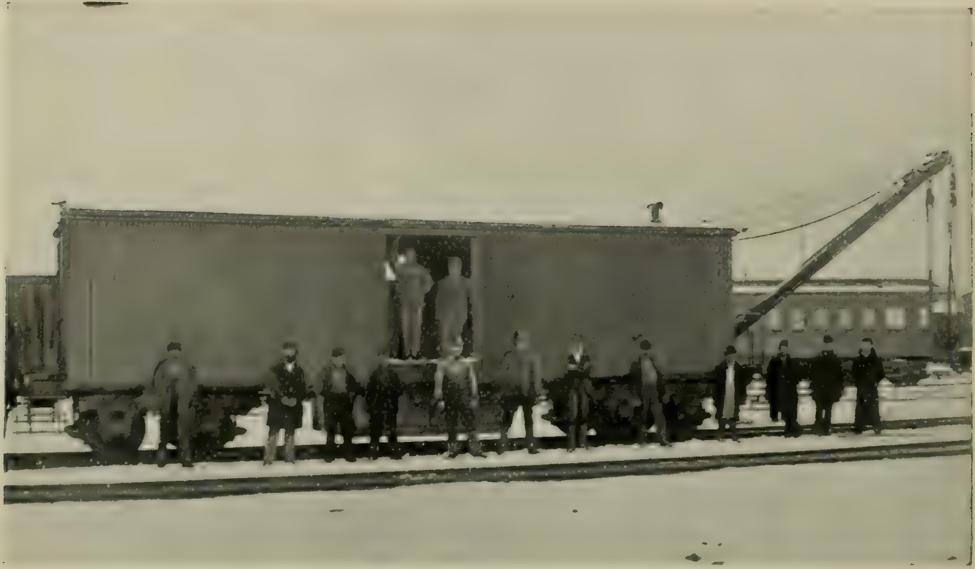
The engines are double, with cylinders nine inches in diameter by twelve inches stroke. There is a locomotive link reversing motion for traveling and operating the machinery in either direction. The cylinders are jacketed with asbestos, wood, and planished iron.

The boiler is of suitable size for the full capacity of the engines, is constructed entirely of flange steel, and has one hundred and thirty-four tubes two inches in diameter. Each tube is connected to its crown sheet by copper ferules, insuring durability and freedom from leakage. There are shaking grates, and lever for operating the same, the grate bars being about five-eighths of an inch apart. A jacket of asbestos, wood, and planished iron covers the boiler. The smoke stack is about four feet long. There are also a locomotive pop safetv-valve, trv cocks, gage cocks, water gage, blow-off cocks, etc. For feeding the boiler there is a lifting injector of suitable size. The water tank, of plate steel, will hold two hundred gallons. A coal bunker is provided.



TEN-TON AMERICAN CRANE.

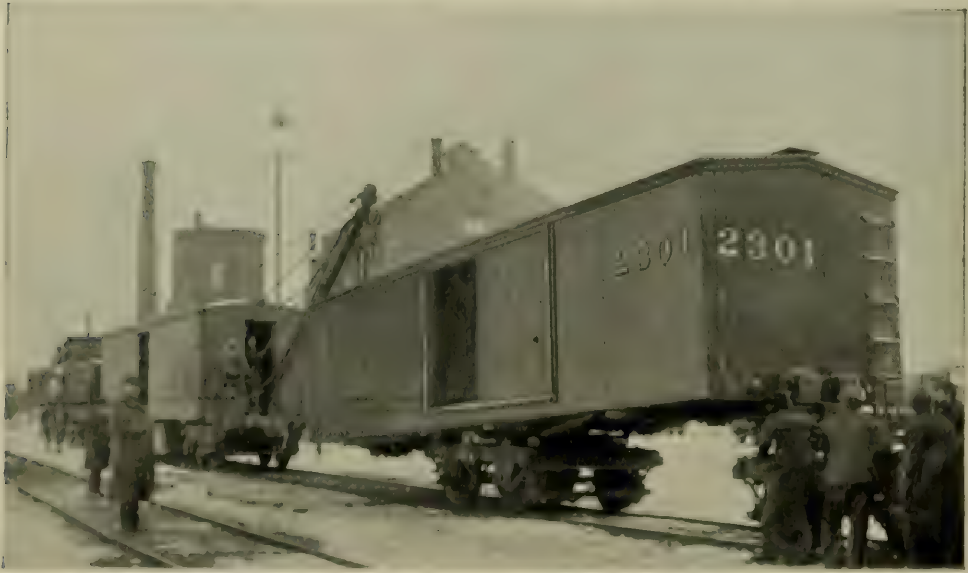
The tool and living car is an important as well as interesting feature of the wrecking equipment. It is usually divided into a tool



COMBINED DERRICK AND TOOL CAR.

and a living room and a kitchen. The tool room contains the hand tools, such as jacks, ropes, tackle, bars, wrenches, etc. The living room is provided with seats, which can be utilized as sleeping-berths when required, a folding dining-table, lockers, and a desk. The kitchen is equipped with a range, coal-bin, lockers, and a water-tank.

For raising weights a short distance, and for separating the wreckage so that the crane can get hold of the pieces, lifting jacks are used. These may be either hydraulic or screw jacks. The former are operated by hydraulic power, generated by small hand-pumps placed within the jacks themselves. For the hydraulic jack quick work under heavy

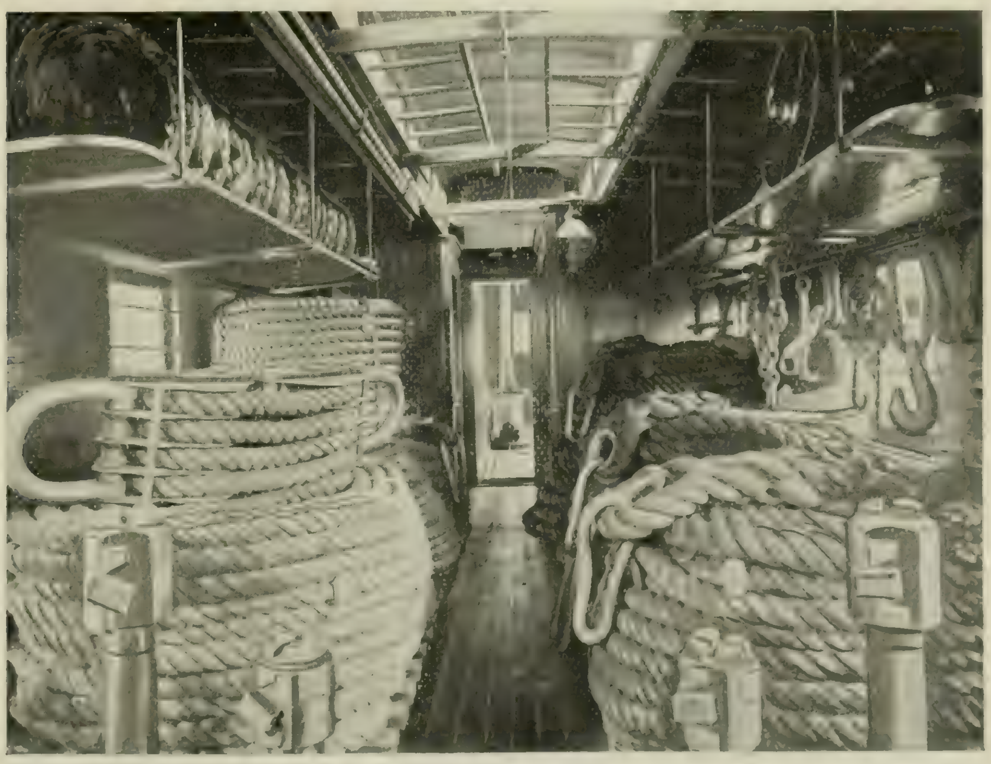


USING A DERRICK CAR FOR PUTTING TRUCKS UNDER A FREIGHT CAR.

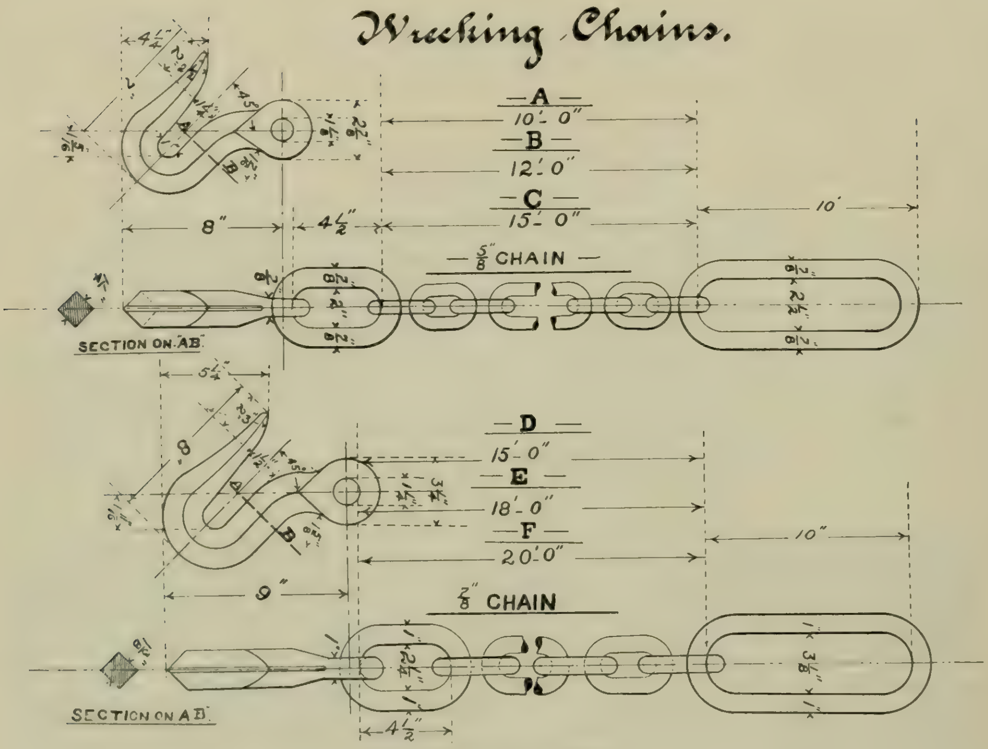
load is claimed. The screw jack is operated on the well-known principle of the screw and lever. Its claim is simplicity of construction and ease of maintenance. Good work may be done with either type, and each has its strong points.

Wrecking frogs and wedges for rerailing cars are of various kinds, but all depend on the principle of the inclined plane. They are so designed as to cause the wheel, in the moving of the car, to rise, and at the same time to crowd toward the rail, and to slide onto it as soon as the proper level is reached. Wrecking frogs, as well as other wrecking tools, should be as light as the work will allow, as they frequently have to be carried by hand from place to place around a wreck.

Rope is distinguished as to size by its circumference in inches and fractions of an inch. No. 1 manila rope is the best fibrous rope for wrecking purposes. Fibrous rope should never be stowed away until it is thoroughly dry, and should be kept in a dry place. Dampness weakens it, and makes it stiff and hard to handle, and is apt to swell it to such an extent that it is unavailable for use in the blocks for which it was intended, and through which it would run freely when dry. A four-strand rope is the best for working in tackle blocks. Being rounder than the three-strand, it produces less friction. When not in use, rope should be secure from contact with acid of any



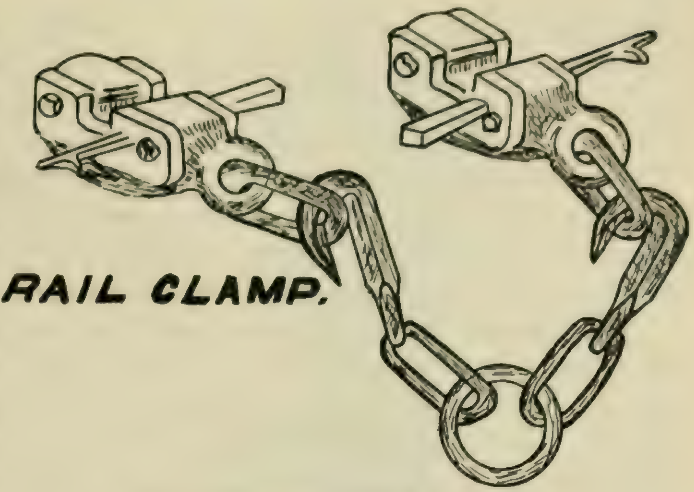
TOOL-ROOM OF A WRECKING CAR.



WRECKING CHAINS.

kind, or lime, soda ash, ashes, fertilizer, or even sand. After having been in contact with anything of this nature, it should be thoroughly cleaned. Tarred rope is seldom used in this service, because in cold weather it stiffens so much as to be almost unworkable. If, however, a rope is to be used in water only, as a drag rope or otherwise, it is well to have it tarred lightly, or, perhaps better still, well oiled. Wire rope is in many respects superior to fibrous rope for wrecking purposes. It is much lighter for the same service, will last longer, and is not affected by dampness. It is about four times as strong as manila rope.

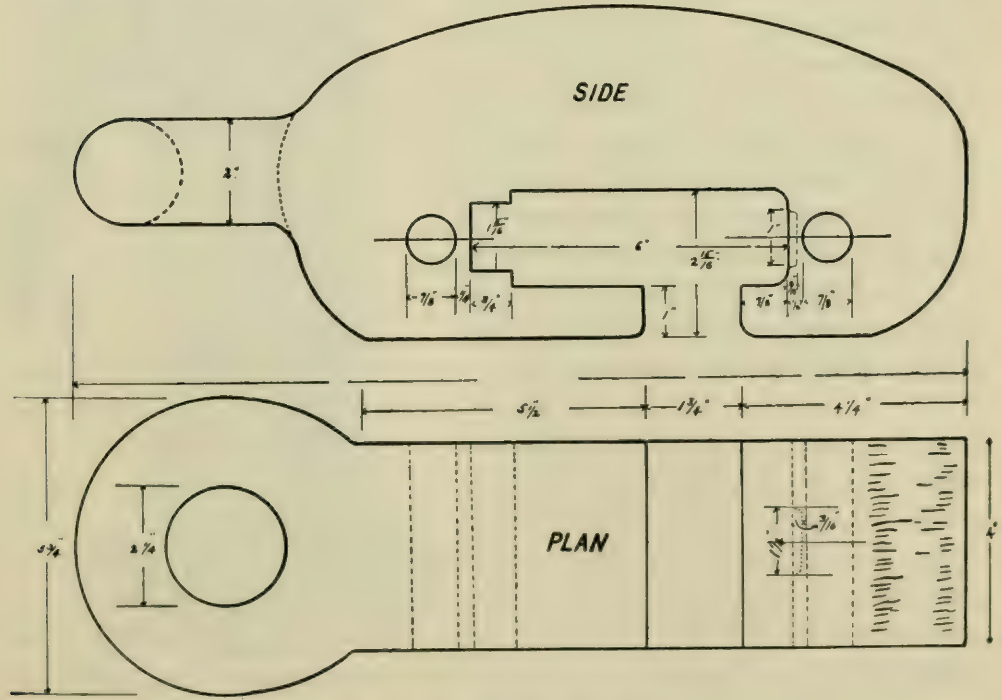
WRECKING FROGS.



FOR FASTENING TACKLE TO TRACK.

A tackle block consists of a frame containing one or more groove-edged pulleys technically known as sheaves, which turn loosely on a common shaft. Formerly these frames were made of wood, but, owing to the very hard usage they receive in wrecking, they are now made of iron or steel. The theoretical advantage gained by tackle blocks where one rope runs through the whole is indicated by the power multiplied by the number of folds in the rope. This advantage is, however, considerably diminished in practice by stiffness of the rope and friction in the pulley bearings.

Mr. Joseph Glynn, in his excellent work on crane construction, recommends that hoisting chain be made with short links of oval form, the links to be no longer than is necessary to permit the use of tools for soundly welding the iron. His own practice induces him to recom-

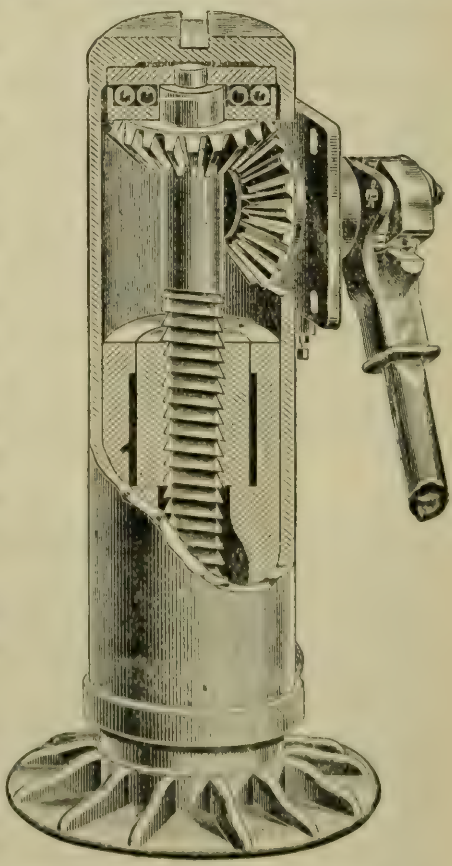


RAIL CLAMP DRAWN TO SCALE.

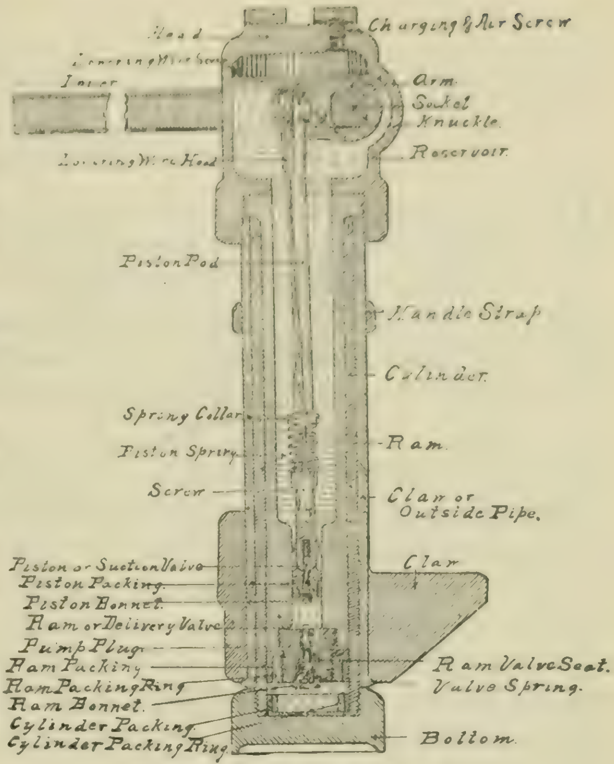
mend that chains above an inch in diameter should not be used for crane work, preference being given to the smaller sizes, say, ⅝″, ¾″, or ⅞″ iron, the strain upon the chain to be reduced by increasing the number of the parts that bear it, by means of blocks and pulleys. The writer does not recommend links more than ¾″ in diameter for hoisting chain, on account of the excessive length of link in larger diameters, requiring a greater diameter of hoisting drum to avoid bending the links as they are wound under load around the drum.

The hoisting drum for chain should be spirally grooved to receive the edge of each alternate link. This prevents the chain from twisting as it winds, and gives each link a firm bearing, thereby reducing strain. The links of chain slings, or of chain for direct pulls and like uses, may be of any desirable diameter, since they are not subjected, like those of chain passing through tackle blocks, to the additional strain due to short bends. The hooks used with tackle blocks and chain should be carefully proportioned to the duty they have to perform. An egg-shaped section, the larger diameter on top where the rope or chain bears, gives the best results generally. The opening of the jaws of the hook should be sufficient to prevent the jamming of the rope or chain in the hook. A hook for hitching to the link of a chain is made of diamond-shaped section, with jaws open just enough to admit a link edgeways. A double hook of this kind may be used in making a quick splice of a broken chain, or for joining chains. When subjected to heavy transverse strains, hooks are apt to bend, and for this reason a shackle, which is simply a hook so arranged that both ends carry the load, is more suitable for lifting very heavy weights, such as locomotives.

For illuminating purposes at wrecks, different kinds of lights are used, but, so far, the main dependence has been placed on torches of large size mounted on posts driven into the ground at convenient points, and of smaller size for carrying in the hand.


BALL-BEARING SCREW JACK.
NORTON TYPE.

The actual work of clearing away



SECTION OF CLAW TYPE HYDRAULIC JACK.
WATSON AND STILLMAN

HYDRAULIC CLAW JACK.

a wreck is practically indescribable, even in a general way, as no two wrecks are alike. The aim is to save from further damage everything of value possible, consistent with the quickest reopening of the line for traffic. An oil wreck is the most dangerous and trying to handle, on account of its liability to fire. Fire usually results in explosions of the burning oil-tanks, making a very dangerous situation. Burning oil should be confined in as small a compass as possible, and then, if in large quantities, allowed to burn out, as there is but little chance of putting the fire out. In some cases, where the fire is a small one, the oil can be worked into positions favorable for smothering the fire with earth, the oil being run to such points through trenches dug for the purpose. The application of water serves only to make matters worse, by spreading the oil over a larger surface, permitting it to burn more freely. The use of a jet of steam for putting out oil fires has been suggested, but this method is seldom available at a railroad wreck. Where there are burning oil cars, the first thing to do is to get everything movable away from the fire as soon as possible, in order to prevent the fire from spreading. On some roads a small cannon is used for firing a shot into a burning oil tank, to let the oil escape before gas is generated and causes an explosion.

With the great improvements brought about within the past decade in the construction and maintenance of track, bridges, engines, and cars, and in train-operating methods,—notably in the latter by the introduction of the absolute block system, which keeps trains a certain distance apart,—the chances for accident have been reduced to a point far below that gained in any other mode of travel. If statistics prove anything, it is that railroads offer by far the safest method of travel yet devised.

LOCATING A PUBLIC WATER-SUPPLY.

By Daniel W. Mead.

THE source of a public water-supply is one of the principal controlling factors in the design of a public water-works system. On the elevation at which water can be obtained depends the possibility of a gravity system or the necessity of pumping works. And, if the latter are necessary, the elevation further determines the class of pumping engines which must be used. On the quality of the supply depends the necessity of filtration, clarification, softening, etc., and on its freedom from present or possible future pollution depend the freedom of the community from the possibility of epidemics and the degree of vigilance with which the supply must be guarded. On its quantity depend the necessity of storage reservoirs and the expensive line of public works which this necessity involves. In fact, it may be stated that the selection of a source of supply is the paramount question in the design of a water-works system, and on it, perhaps more than on any one feature of the works, depends its financial and practical success.

Of the larger cities of the United States it is safe to say that the supply of at least fifty per cent. of them is entirely unsatisfactory, and the supply of a large proportion of the remaining number is far from what it should be. No question is, in fact, giving more trouble in its solution at the present time than the question of the source of the water-supplies of the cities of the United States. This, to a considerable extent, is unavoidable. A city has a limited choice of possible sources, and from such sources the problem often is to select the least objectionable. Again, supplies which may have been satisfactory at the inception of the works have been radically changed in character by the settlement of the country. The trouble is also due, in many instances, to a failure, in the original designing of the system, to properly consider the hydrological resources of the localities. Superficial examinations alone are made. The resources of a locality are examined as though they were isolated phenomena, whereas they are a part of a general system which, if studied and considered as a whole, would throw more light on the question and lead to a broader understanding of local resources and often to a more intelligent selection and design of the special system considered. The lakes, streams, and watersheds are self-evident, as are the ground waters which supply the common wells of each community, and these alone are commonly investigated. The deeper sources, when such exist, are often unconsidered or overlooked, though they sometimes offer the cheapest means of securing pure and wholesome supplies. Intelligent design demands that due consideration be given to each possible source, and that the items of purity, quantity, cost, future extension, and protection from present or future contamination shall have each its due weight in determining choice.

To thoroughly comprehend the problem involved in the selection of a public water-supply, it is necessary to consider in detail the hydrology and hydro-geology of the entire region. The following discussion of the water supplies of southern Wisconsin and northern Illinois will serve to illustrate the extent and character of the necessary lines of study and inquiry.

The rainfall, to which ultimate source all available supplies may be traced, is exceedingly variable in quantity, and its careful study must precede the considerations of most questions of water-supply, and is especially important when limited watersheds are considered for surface supplies.

The ultimate disposal of the rainfall is modified by climate, temperature, vegetation, and geological conditions, which differ, not only with the locality, but with the season, and previous relative humidity. The rainfall is partially re-evaporated. A portion is absorbed by vegetation and utilized in plant growth and transpiration from plant surfaces. A large additional percentage flows away in the streams, while the balance sinks into the soil, furnishing the dry-weather flow of streams, the reservoir from which plant life draws its necessary supply during the rainless periods, and the waters which saturate the underlying geological strata.

The yearly distribution of the rainfall largely influences its ultimate distribution. When it is evenly distributed during the year, a larger proportion is absorbed by vegetation, imbibed by soil and rocks, and evaporated, and a smaller flows away in streams. Where the rainfall is concentrated in short periods, a larger percentage flows away in streams as flood waters, and a smaller is appropriated in other ways. The variation in the amount which may be assimilated by vegetation or evaporated during a short period is limited. So to a less degree is the imbibition of soils and rocks. For these strata, if once saturated, force the water to flow away as flood waters. A fall of an inch per hour may produce a considerable flood, especially with no vegetation and with frozen ground. The same fall distributed over twenty-four hours, with vegetation at its best and low ground water, may be scarcely noticeable in the flow of streams.

The relative amount of the total rainfall which may find its way into any one of the channels mentioned depends most largely, however, on geological conditions. The rate of inclination and nature of the surface, influencing the rapidity of the passage of waters over the surface, have a most important influence on the amount of water which flows away in streams or is lost through one of the other channels. With slight slope and high porosity the waters may cease entirely to appear in watercourses, but all be either evaporated, assimilated, or sunk into the porous strata. The geology of southern Wisconsin and northern Illinois, as it relates to the distribution of the waters of this region, may be briefly described as follows : This entire region is underlain by the Archæan rocks of unknown thickness, which, as far as our knowledge goes, may be regarded as the foundation rocks on which the overlying deposits rest. Among the Archæan rocks of Wisconsin are found the earliest of the known rocks, and from these have been formed, directly or indirectly, all later formations.

Since the beginning of geological history, the same agencies that are now at work pulling down the land surface and filling up the sea have been at work, aided or hindered by the great variations in climate. The rains soften and wear the rocks' surface, and cause the decomposition and disintegration of the most lasting rocks. The sea tumbles the rocks into the surf, and grinds them into sand and pebbles. The accumulated work of these agencies through ages has sufficed to pull down continents and build up deposits, which have formed new extents of the land surface, and which in their turn have been disintegrated and destroyed to form new and later deposits.

In this way the Archæan deposits were worn and disintegrated and formed the extensive beds of Potsdam sandstone which underlie almost the entire area under consideration, except that small portion where the Archæan rocks themselves still show their outcrop above the surrounding deposits. The Potsdam deposit consists essentially of sandstones derived from the broken quartz grains of the decomposed granites and allied rocks. Variations more or less extensive in the position of land surface and the condition of deposition gave rise to the series of deposits which lie above the Potsdam, and which are all of more or less importance in the question of water-supply.

It is, however, unnecessary for our purpose to enter on a detailed history of the geological developments of this territory. It is sufficient to know that the land gradually rose from the sea, until, at the end of the Carboniferous period, it was all above the sea-level.

The topography of this region at the beginning of the Quaternary age differed greatly from the present rolling prairie land which makes up most of this area. In its stead, rugged hills and deep ravines marked the landscape. The rocky hillsides were largely bare, and a light soil existed only in the valleys. The Mississippi river flowed in the same general course that it now occupies, but at a relatively lower level of from one to two hundred feet. The Lake Michigan basin was then a wide, deep valley, through which flowed a river draining an extended territory, probably including the valleys of Lakes Superior and Huron. From the southern extremity of the present Lake Michigan, it flowed in a southwesterly direction to its outlet in the Mississippi river. During the Quaternary age there were epochs of great cold, during which the vast accumulations of snow and ice in the north were unmelted by the short summer heat. Great glaciers were formed, which pushed down from the northward, covering most of this region except southwestern Wisconsin and northwestern Illinois.

This irresistible ice flood overran valleys and hills, and covered most of this area to a depth of perhaps several thousand feet. The hills were planed and rounded off, and the ice flood filled the valleys deeply with the detritus pushed before it and carried within it. Vast floods of water came from their melting fronts, and caused successive deposits of the various drift materials. The depths of these deposits in various places vary from nothing on the hilltops of the driftless area to three hundred and fifty feet at Janesville, Wis., in the old cañon of the Rock river.

The drainage system, which was developed prior to the glacial epoch, was greatly altered by the filling of valleys and the grinding down of the hills. The Mississippi river valley was partially filled, and its course in many places altered. The Lake Michigan river valley was filled to a point near Chicago, and the smaller drainage valleys of this area were entirely destroyed. The topography had also widely changed ; in place of the rugged hills of the pre-glacial epoch, the present prairie land resulted. The drainage system which has since developed was largely marked out and modified by the effects of the ice and by the glacial floods resulting from its melting.

As the Lake Michigan glacier receded, it still rested over the present outlet of the lake, and the lake poured its waters down the present valley of the Illinois river in a flood far in excess of the modern river. The glacial floods also poured through the Mississippi valley, in each case excavating deep in the drift a wide valley, which the modern river but poorly fills.

Having thus briefly considered geological causes, the present geological conditions may be briefly reviewed. In the indurated rock formations, lines of exact demarcation seldom exist between the various strata. One stratum usually grades gradually into another. Changes in the controlling influence which modified deposition were usually not radical ones, but obtained only gradually.

A like condition applies to the character of a stratum throughout its geographic extent ; the conditions at one point might favor the formation of limestone deposits, while those more or less remote might be favorable to the formation of shale. Hence we find, if the same stratum be followed up, often even in very limited distances, that it may merge from a sandstone to a limestone, or from a limestone to a shale, and the reverse ; or from a coarse-grained stone to one of finer and more impervious qualities. The more widespread and universal the conditions controlling deposition, the more uniform the character of a stratum throughout its extent. Hence the character of a rock deposit which we may expect to encounter in drilling is often highly problematic.

The underlying Archæan rocks have a slope in all directions from their outcrop in northern Wisconsin, being about 2,000 feet above sea-level at their highest outcrop. The superincumbent strata follow this general slope to a considerable extent. The surface also follows the general dip of the strata at present, as it has through all past geological ages, the older geological deposits being at their outcrop the higher ; in travelling from the original Archæan nucleus in each direction, the traveller will descend in elevation, while he ascends in geological succession, as he approaches nearer the sea-level.

In considering the hydrological conditions of the various strata, it should be noted that all are water-bearing to some extent. Even where the ratio of absorption is comparatively small and insignificant, the cracks and fissures often play an important part. This area, like many others, is marked by an alternation in the position of rocks, varying largely in porosity, strata of high porosity frequently lying between those comparatively impervious. This variation is somewhat equalized by cracks and fissures, but the difference is still so marked as to create a great difference in the character of the flow.

The outcrop of these highly pervious strata, at high elevation on the watershed of the valley, gives rise to hydrostatic pressure within the strata, which is not wholly equalized by the transfusion of waters due to porosity or rupture of the strata. Hence in the lower portions of the valley these waters often come to the surface with considerable head through natural channels as springs or artificial channels as flowing wells.

Of the waters of this region the surface waters are the most obvious. It is found that the stream-flow amounts to from twenty-five to forty per cent, of the annual rainfall, depending on the modifying circumstances herebefore mentioned. From thirty to fifty per cent. of the rainfall is probably evaporated and utilized in plant growth, while the balance is imbibed by the underlying strata.

The stream-flow is largely derived from the ground water, which flows toward the river with a surface slope more or less rapid in accordance with the porosity of the water-bearing strata in which it occurs. It is seldom that the water flows from the river to the land, even in extreme high waters; for the rivers, especially in high waters, carry much silt, and an outward current soon stops all pores by filling them and makes a practically impervious bed. This is the cause of failure in filter galleries which depend on the seepage of rivers for their supply. The streams sometimes flow through beds of sand and gravel, the visible stream being but a portion of the whole, including the invisible one which flows around and under it. This phenomenon is not largely developed in this area in any one stream, but is locally developed on most of the streams. The possibility of utilizing such ground waters by large wells, drive wells, or filter galleries will be readily understood. These beds of sand and gravel are sometimes continuous for great distances, and, being surrounded by comparatively impervious clay, they exist in what may be called underground reservoirs or lakes, or, as broad underground streams, flow through the gravel and sand toward their outlet in some distant watercourse. They derive their supply directly from the rainfall on their water-shed, the extent and charactér of which is usually difficult to determine, though on these features the availability of such sources for large water-supplies depends.

Surface and ground waters are liable to be contaminated by any organic filth on their watersheds. These waters are seriously affected by the settlement of the country. In many places where the population is still small and scattered these waters may be pure and satisfactory for domestic use. But along the streams where the larger cities are situated and in all thickly-inhabited localities the increase of population has rendered them unfit for use. The streams are now often used as the dumping-ground of waste materials, both liquid and solid, and, although stringent sanitary laws may in the main prevent gross pollution of these watercourses, it can never keep from them all of the liquid and solid accompaniments of a dense population. Waters once receiving organic matters retain them indefinitely, for, although the comparative amounts may be lessened by dilution, deposition, and bacteriological agencies, there is not a river long enough to entirely purify itself during its flow from source to sea, when once thoroughly contaminated.

The ground waters may, as a rule, be regarded as less liable to gross pollution than the open streams of the country, as they do not offer in such an unobstructed manner the temptation of the means of rapid disposal of waste. And, when only slightly polluted, the filtering qualities of the soil often afford a means of clarification, where the matter causing pollution is not too concentrated or constant in supply. Such sources of pollution as vaults and leaching cesspools, however, often overtax the purifying powers of the soil, and cause a local pollution of the ground water even more dangerous than that of the polluted streams.

The fact of the limited occurrence of water in all strata has been already noted ; hence, if the amount of water needed is small, the drill will find it in almost any deposit in amounts proportional to the porosity of the stratum or the occurrence of cracks and fissures in it. Outside of this general consideration, several deposits are especially important for their water-bearing qualities. Of these, the Potsdam sandstone is the most important. It has an outcrop of about fourteen thousand square miles, affording an ample watershed. From this source are derived numerous artesian and deep wells, which have been developed throughout the extent of the outcrop. The St. Peter sandstone is next in importance in this area as a source of water. Its outcrop extends over about three thousand square miles, and in a large part of this area it lies above the Potsdam and is first encountered by the drill. Its elevation is, however, less than that of the Potsdam, and hence its waters have not usually as great a head, and consequently do not as often furnish flowing wells.

The drift deposits are sometimes so extended that they may produce all phenomena observable in the lower strata, such as artesian flows and copious springs at numerous points within this area. Many of the other deposits of this area may be made available as sources of water-supplies by driving infiltration tunnels through their mass, the tunnels being of sufficient extent to produce the necessary amount of water.

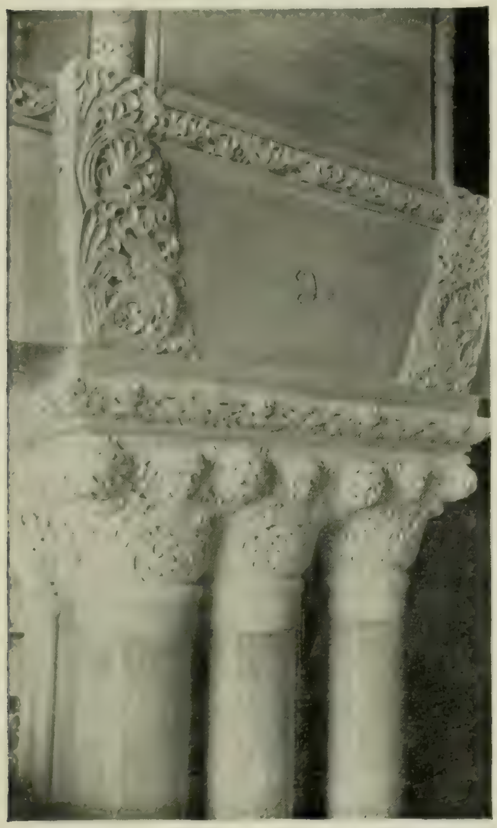
The deep and artesian waters often flow through miles of material and are effectually filtered from all organic contamination, and, if unpolluted at their outlet, are organically pure. Wells drawing their waters from such sources offer a supply second to none in organic purity and freedom from all risk of contamination. While the deep waters are organically pure, they are very likely to contain much larger percentages of inorganic salts than surface waters.

Enough has been said to show that, in searching for the most favorable water-supply, it is important that local conditions be ascertained and local geology and topography understood, in order that all possible sources may be known and the probable cost of obtaining waters from each and the probable quality and quantity of the same may be rightly judged.

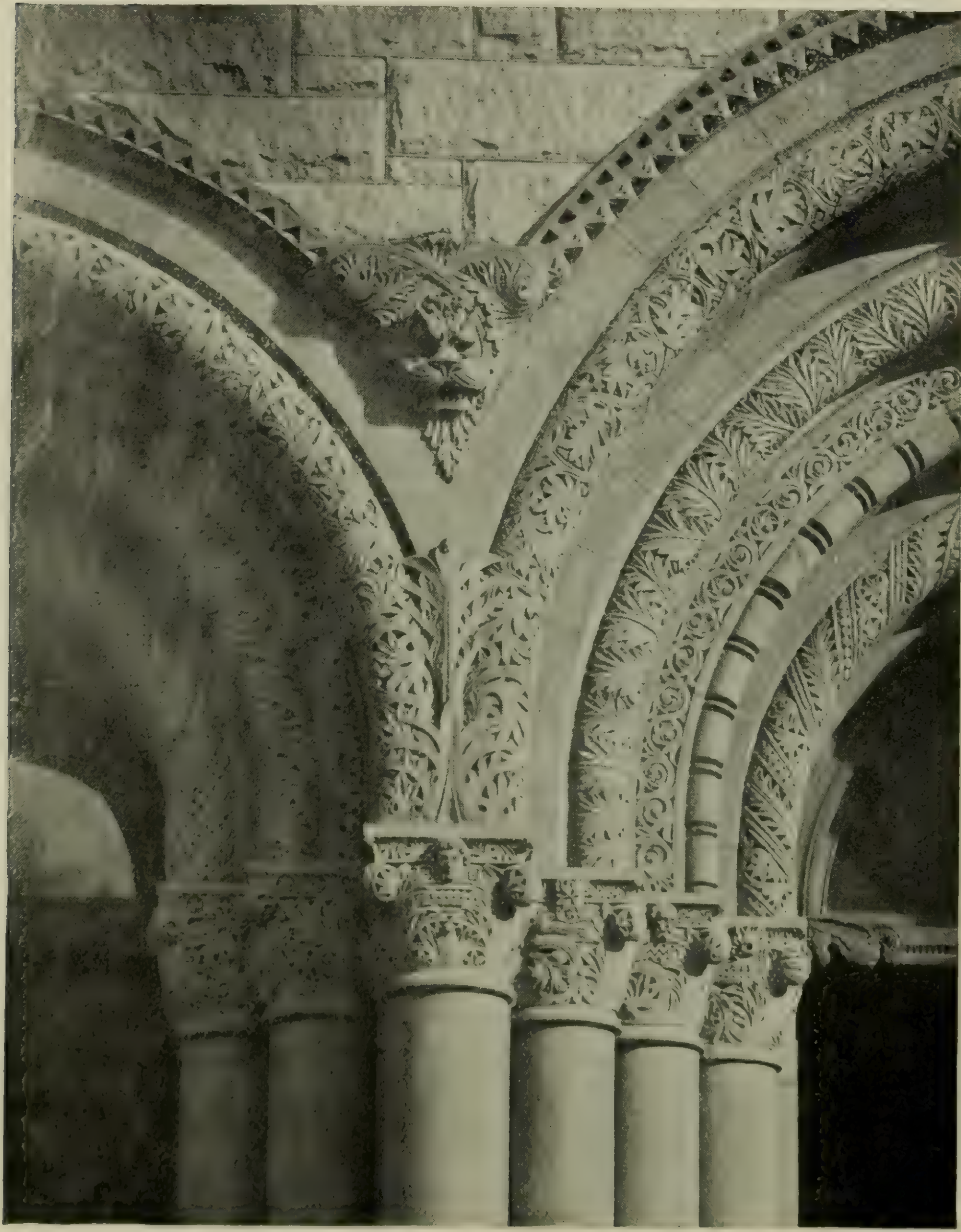
ARCHITECTURAL SCULPTURE IN AMERICA.

By Russell Sturgis.

THERE have been a few attempts to apply a new and living architectural sculpture to American buildings, and these attempts seem to be worthy of mention. But, architectural sculpture being a term of large application, let it be confined in this short article, to the consideration of sculpture of a purely decorative character, excluding statuary and even sculpture in relief, when representative and expressional even more than decorative. Thus the six statues by Mr. J. Masey Rhind, which we are all anxiously waiting for, and which are to be set up on the front of the American Surety Building at Pine street and Broadway, New York, will not come within the limits of this paper. And, on the whole, it will be best to exclude also the figure sculptures by Mr. Martiny on the front of the Mail and Express Building on Broadway; although these, as terminal figures, are rather architectural than expressional in purpose. The decoration of such buildings as the Walker Art Gallery at Bowdoin College, by means of statues and busts, selected for their high sculpturesque importance and placed in niches, is, of course, outside of the whole subject of architectural art. How fully-realized and perfected sculpture has been and may be used to adorn buildings is a subject large enough, important enough, and puzzling enough to be treated by itself. The question before us now is the value of such architectural sculpture as, for instance, the late H. H. Richardson put upon so many of the buildings of the last ten years. We need not consider whose power of design it is that these sculptures show. Nowhere in the work ascribed to a modern architect can the outsider feel sure of individual claims to the merit or demerit of a design; nobody



CAPITAL FROM HARVARD LAW SCHOOL.
H. H. Richardson, Architect.

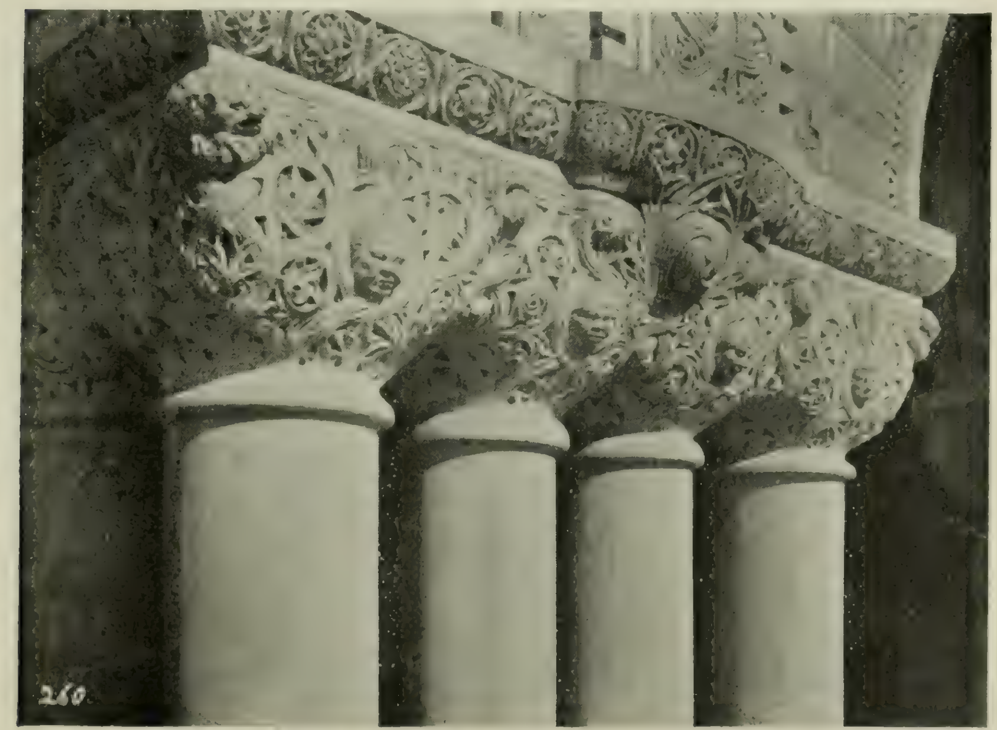


PART OF MAIN PORTAL, CITY HALL, ALBANY, N. Y.
H. H. Richardson, Architect.

but the *habitués* of the architect's office can know anything about this matter of authorship.

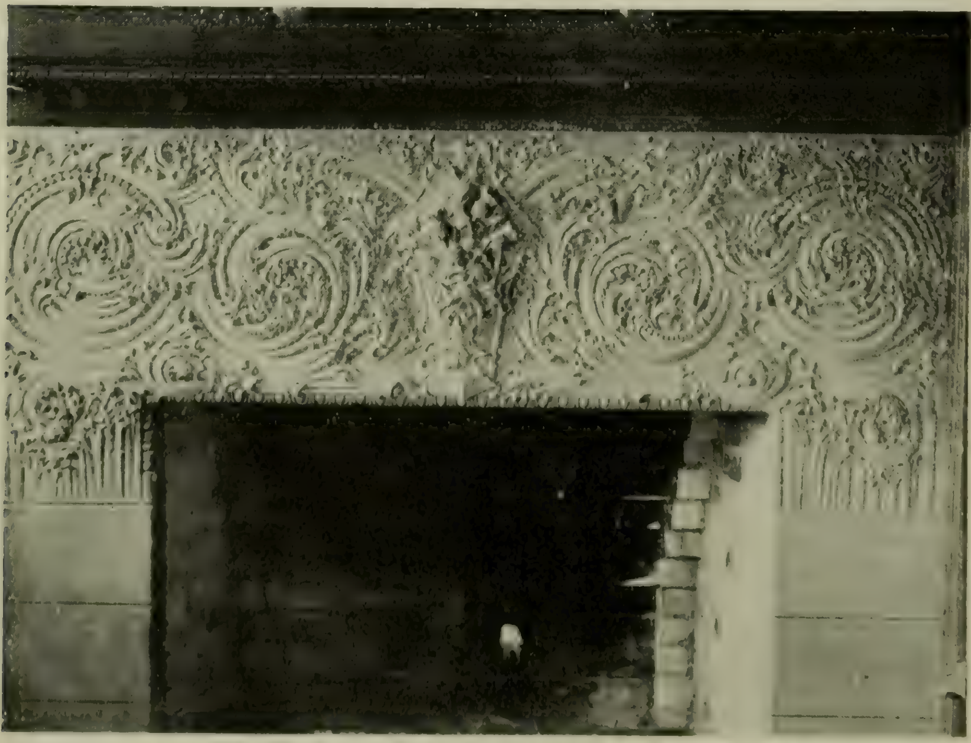
The sculpture to be fairly attributed to Mr. Richardson is, then, Byzantine in general character, in nearly every instance. There is none of it in New York city ; but in the capitol at Albany it is abundant, and it is to be seen in the Harvard Law School at Cambridge, the Pittsburg court house, the Albany city hall, a memorial fountain at

Detroit, and buildings in Washington, Boston, and small towns in Massachusetts. Its characteristic is the crowding of the surface with foliated ornament in very low relief. No space more than an inch or two wide or high, of the panel or frieze or other decorated member, is without some part of a leaf or of a masque or boss or volute forming part of the leafage. All the leafage is modeled upon the Byzantine type, found in the capitals of churches of the fifth and sixth centuries, in the spandrels of Saint Sophia, and in the relief and pierced panels of the same epoch. The capitals of the American work, especially those of single columns of moderate size, are often very closely studied from the originals at Constantinople, or Ravenna, or Venice. The somewhat narrow string-courses and the abaci of the columns and clustered piers are often, as at Chicago and Washington and Detroit, very strictly Byzantine. So are frequently the secondary capitals, as they might be called; sculptured blocks set upon the abaci of the capitals proper and forming impost or terminating a lintel. This foliation is, of course, made up of that modified acanthus leaf which the fifth-century Greeks enjoyed so heartily. There is no lovelier decorative carving than this, in its original form, delicately worked in fine-grained marble; and it may almost be said that the American works is a worthy continuation of it. Certainly it would be hard to find modern architectural sculpture in large quantity more fitted to its



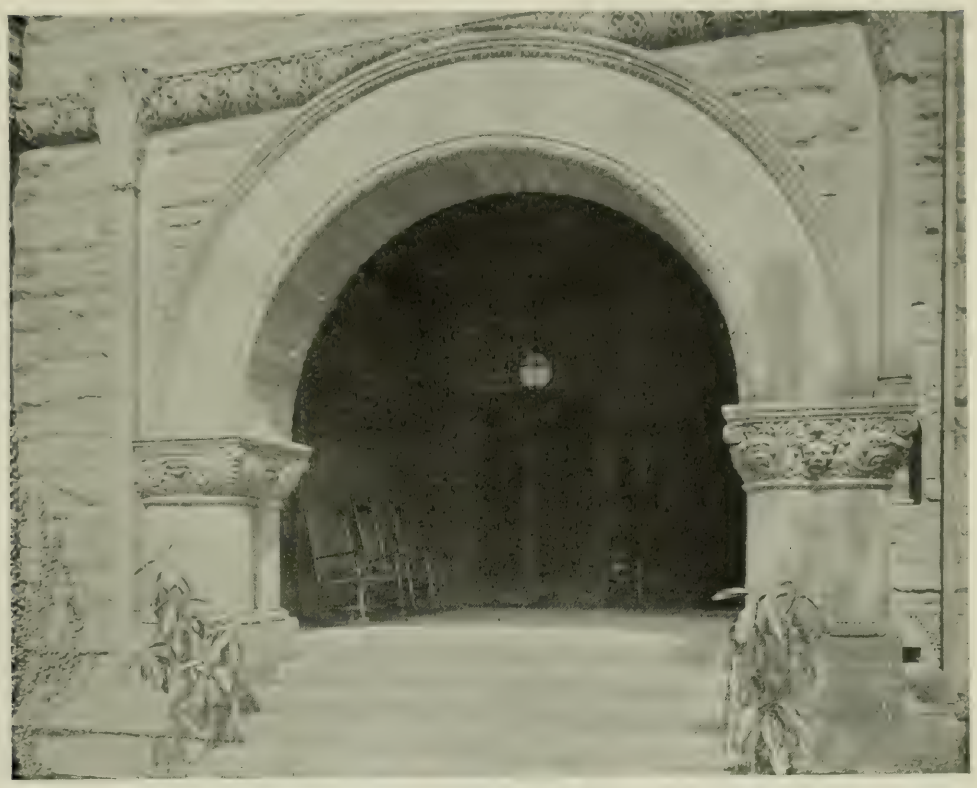
CAPITALS IN THE HARVARD LAW SCHOOL, CAMBRIDGE, MASS.
H. H. Richardson, Architect.

place and its requirements, or of greater individual and independent merit. When, as in the Harvard Law School and again in the law library of the Albany capitol, the type is somewhat changed; when the leafage becomes less sharp, and the relief a little bolder,—something of the original charm is lost. The Byzantine delicacy is gone, and the Romanesque boldness which ought to take its place is not there. Mr. Richardson had made more than one journey in the south of France, and the somewhat feeble sculpture of the Romanesque buildings there, as at St. Gilles and at Arles, had perhaps influenced his feeling in regard to open-air sculpture. Certainly the transition from Byzantine delicacy to northern vigor might have been better managed, and the sculpture of Angoulême, Poitiers, Limoges, Clermont-Ferrand, and St. Jouin de Marnes might have served as prototypes. It is not unreasonable to ascribe to the authors of this modern sculpture the wish and the intention to draw toward northern Romanesque, because the buildings in which their sculpture is found are, in other parts of their decorative design, full of the suggestions of the Romanesque architecture of southern and southwestern France. Indeed, as to the sculpture alone, the somewhat deeply carved roll-mouldings of the Albany city hall are entirely northern in spirit. Moreover, the use of heads, whether of grotesque or of graver design,



CHIMNEY PIECE. CARVED BY HEIDENREICH & STEPHAN.

C. F. Schweinfurth, Architect.

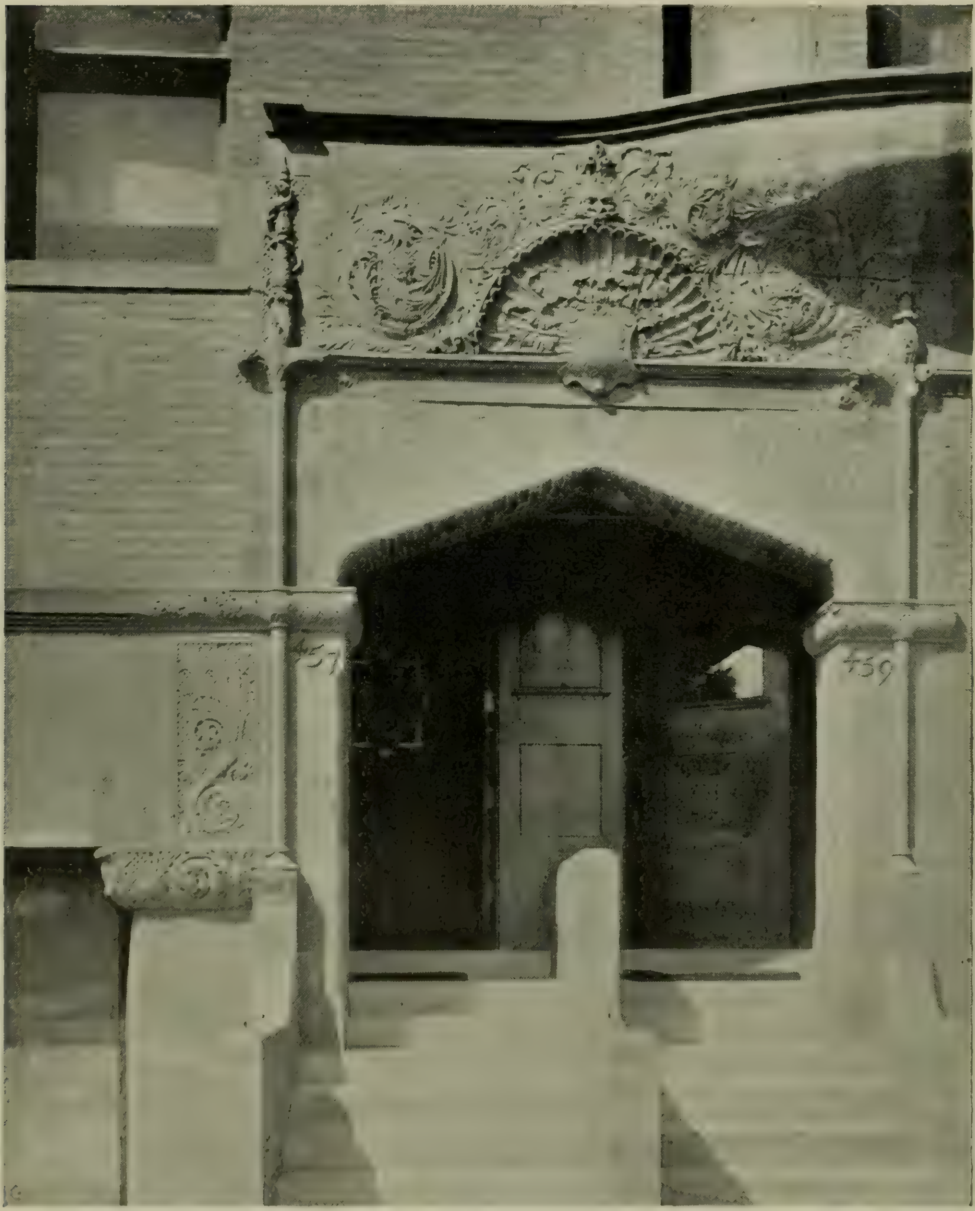


ENTRANCE TO A RESIDENCE IN DETROIT, MICH.

C. F. Schweinfurth, Architect.

as center-bosses in large capitals is entirely northern in spirit; for the Venetian use of heads in similar places is primarily descriptive and emblematical.

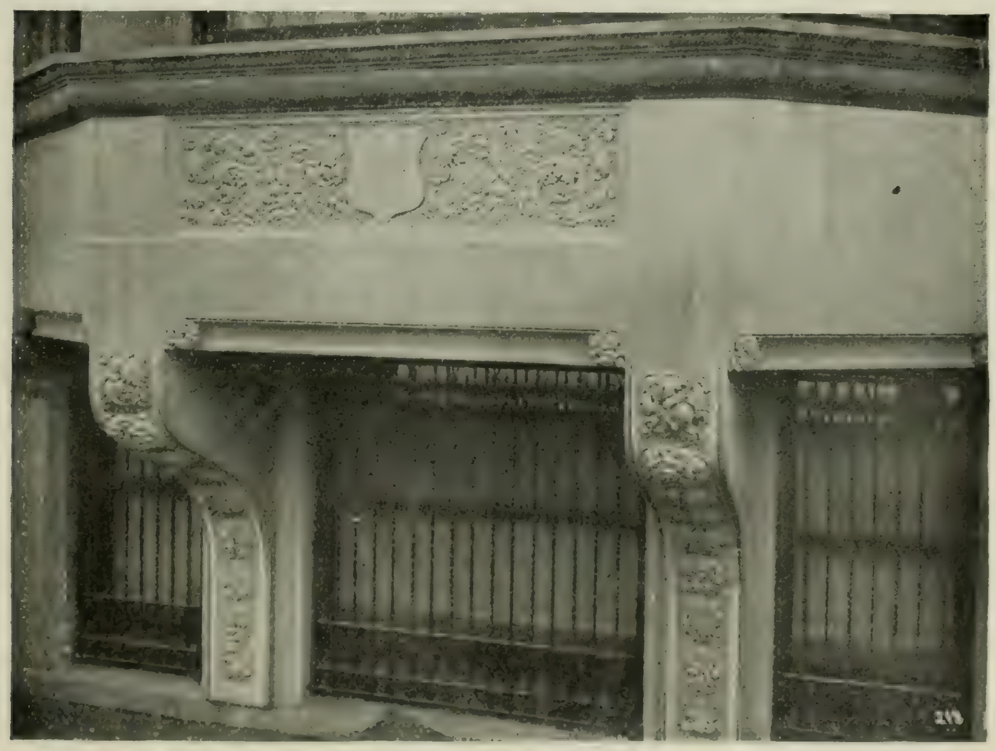
Although the Richardson decorative sculpture loses much of its charm as it passes from Byzantine flatness and sharpness into Romanesque deeper shadows and more rounded forms, the sculpture of essentially Gothic character, as in the North Easton town hall, is often extremely vigorous and of immense value to the building. No better instance can be offered of the charm which may be imparted by the use of sculpture to an otherwise fairly good design than the effective relieving of the large capitals of that building upon the dusky walls behind the arcade. In a building in Albany,—a dwelling house fronting on Washington Park, —having a narrow front with a large segmental arch over a loggia and a smaller one for the entrance doorway, sculpture of a somewhat independent character is sparingly applied with surprisingly good result. The general character of the architectural forms and of the sculpture is, as a whole, that of the earliest French Renaissance with the florid Gothic feeling still strong in it. More than most American specimens of decorative sculpture, this tells upon the whole design of the front.



RESIDENCE IN DETROIT.
Mason & Rice, Architects.

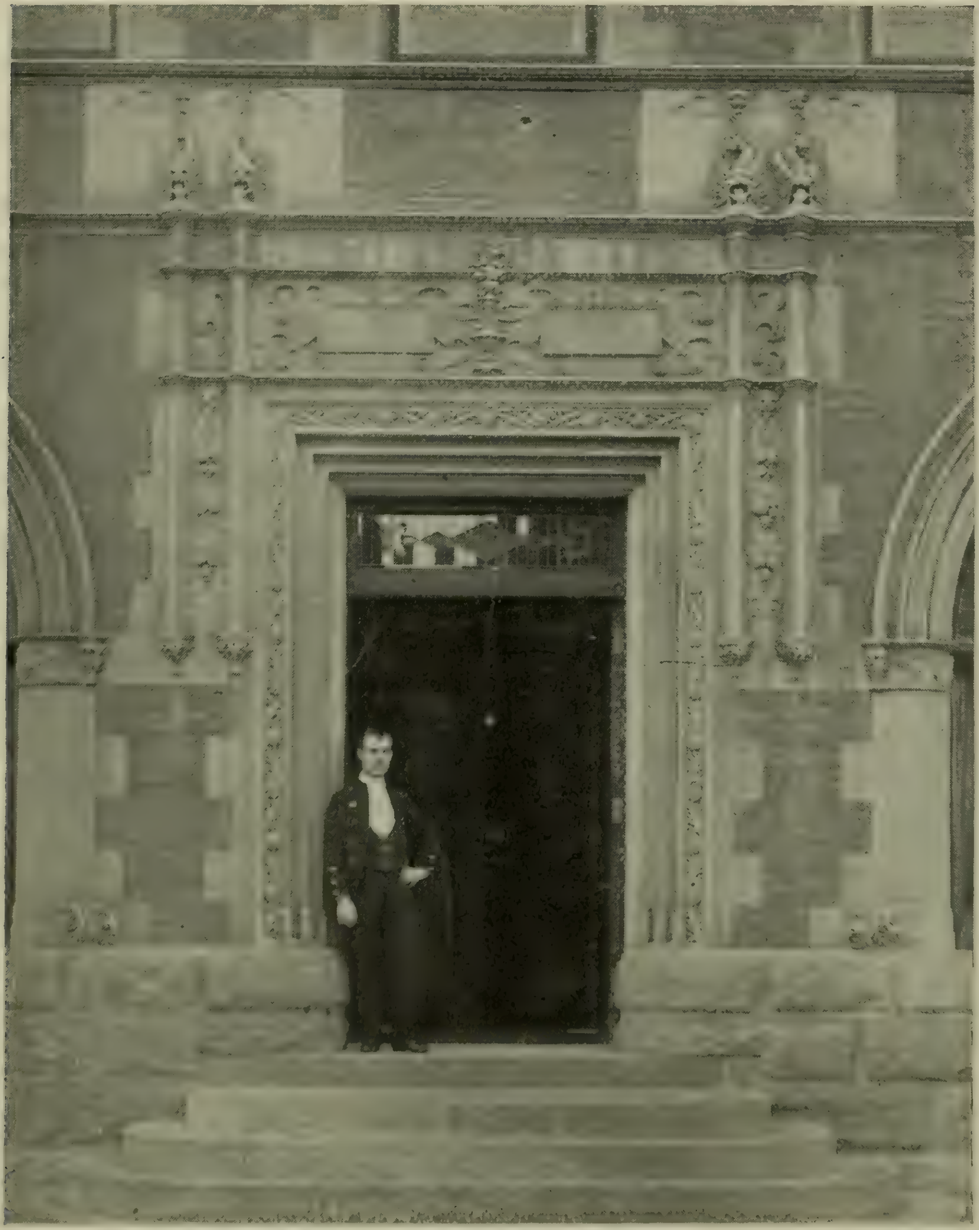
Mr. C. F. Schweinfurth, of Cleveland, has of late, taken up the Richardson system of leafage, and, in different buildings, has modified it in two distinct ways. In some cases, as in the residence of Col. Merriam in Minneapolis, the Byzantine acanthus is treated, at once, with broader leaf masses and with sharp and prickly leaf points. A photograph shows a carved panel above a fire place in Cleveland, in which a scroll is carried by and spread upon a hedge of thistles; and one who studies these thistle leaves will see what forms perhaps some part of the inspiration of the more conventional leafage named above. So, in a stone mantel-piece carved by Messrs. Heidenreich and Stephan from Mr. Schweinfurth's design, an escutcheon is charged with thistle plants in high relief, and the large surfaces on either side are filled with scroll-work, also in relief, in which the Byzantine acanthus puts on a thistle-like and prickly character, in conformity with the central motive. Other work ascribed to Mr. Schweinfurth is in the way of more frankly conventional German Romanesque, like that of Bamberg, though this also is evidently the result of careful thinking out; in other words, it is *designed*, which our contemporary sculpture much more often is not. In the Christian Association Building at Cleveland, this formal carving is combined with fully-realized sculpture of human subject in the porch, and the effect is not objectionable, although the scale of the parts has not been perfectly preserved.

Messrs. Mason and Rice have done some work at Detroit, in which the Richardsonian Byzantine has been used with great boldness in combination with shields and fluttering scrolls. Moreover, in a Detroit church, a great deal of this sculpture has been used in combination with the peculiar inlay of sandstone of different colors, like a mosaic of gigantic scale,—the inlay so characteristic of some beautiful French Romanesque, as in Notre Dame du Port of Clermont-Ferrand.



FROM A HOUSE IN NEW YORK.

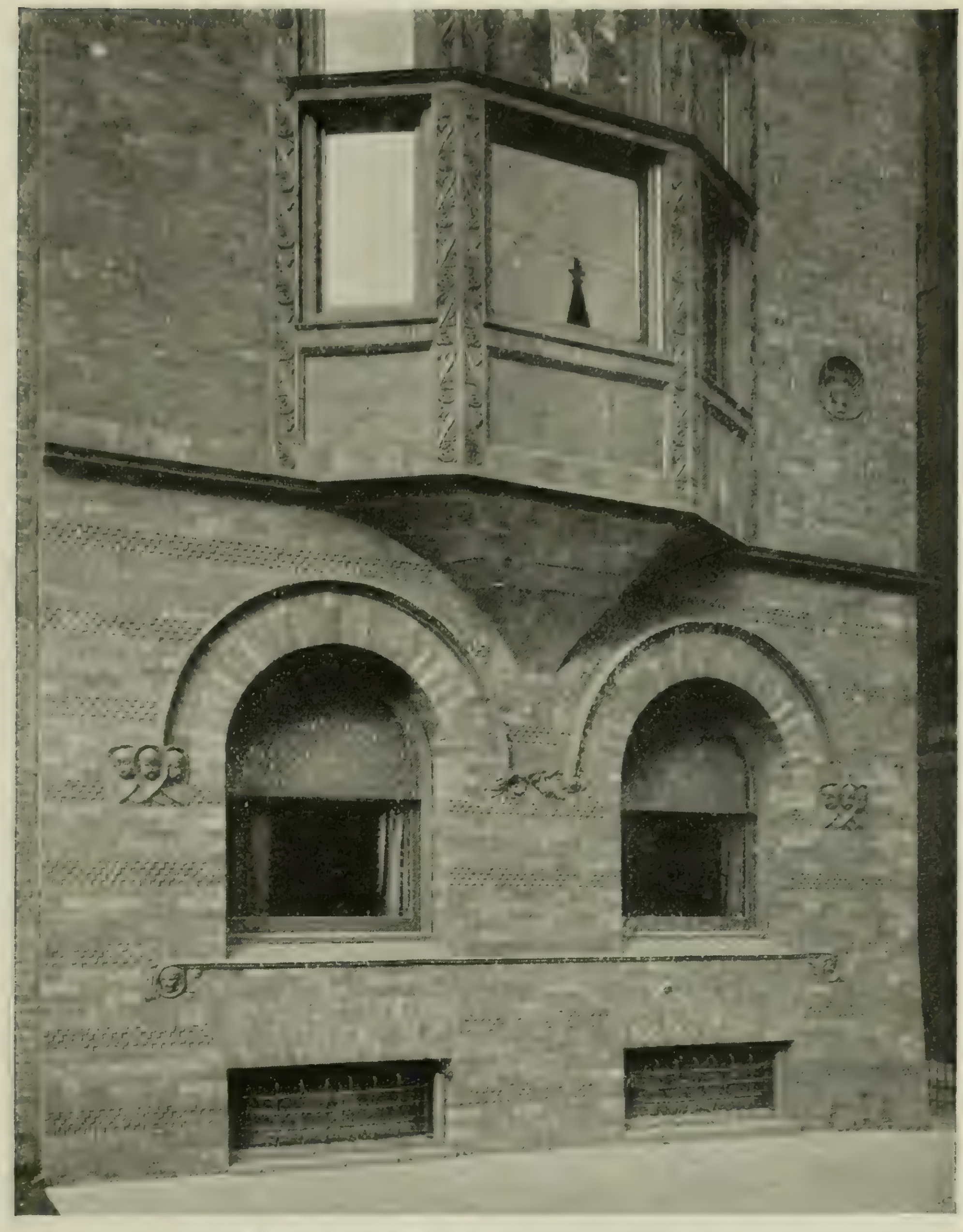
R. H. Robertson, Architect.



ENTRANCE TO THE ART CLUB, PHILADELPHIA, PA.

Frank Miles Day, Architect.

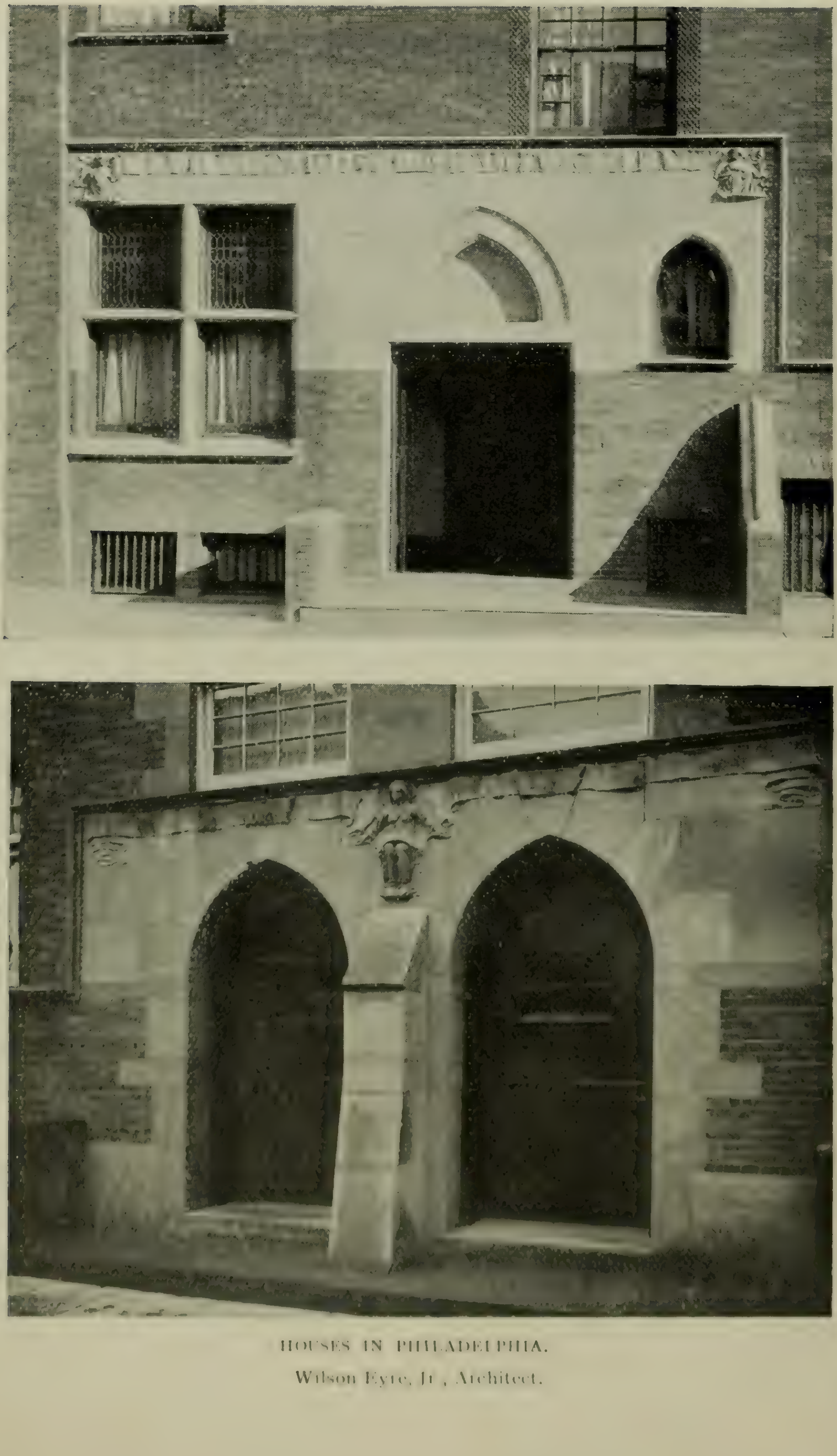
The sculpture of the wall-cornice, especially that of the low round towers which flank the porch, is a remarkable piece of bold designing, in which the deviations from the Richardsonian type are very decided, as, for instance, in the much greater relief and deeper shadows of the foliated ornament. It should be noted, though the subject cannot be discussed here, that Boston architects who are, in a sense, the heirs of Richardson's architectural reputation have produced carving which



A CHURCH CLUB HOUSE, PHILADELPHIA, PA.
Wilson Eyre, Jr., Architect.

should be compared with that of his own time, in any thorough study of this subject.

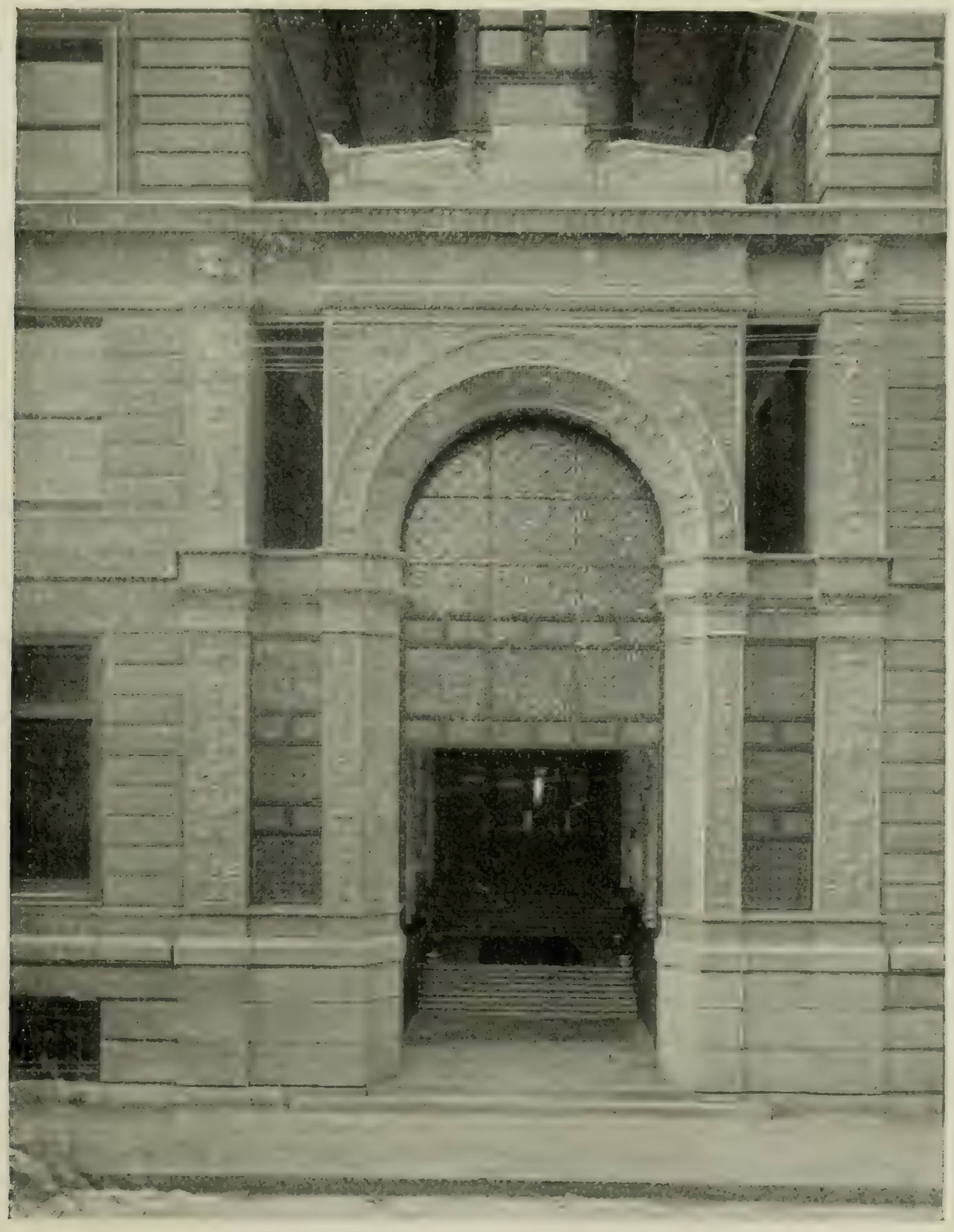
Mr. R. H. Robertson of New York has been the means of giving us a certain amount of architectural carving. Sometimes this appears in buildings not otherwise very notable, whether for cost, or massive construction, or general architectural display. Thus, in the Church of the Messiah in Brooklyn, built of brick and not striking



HOUSES IN PHILADELPHIA.

Wilson Eyre, Jr., Architect.

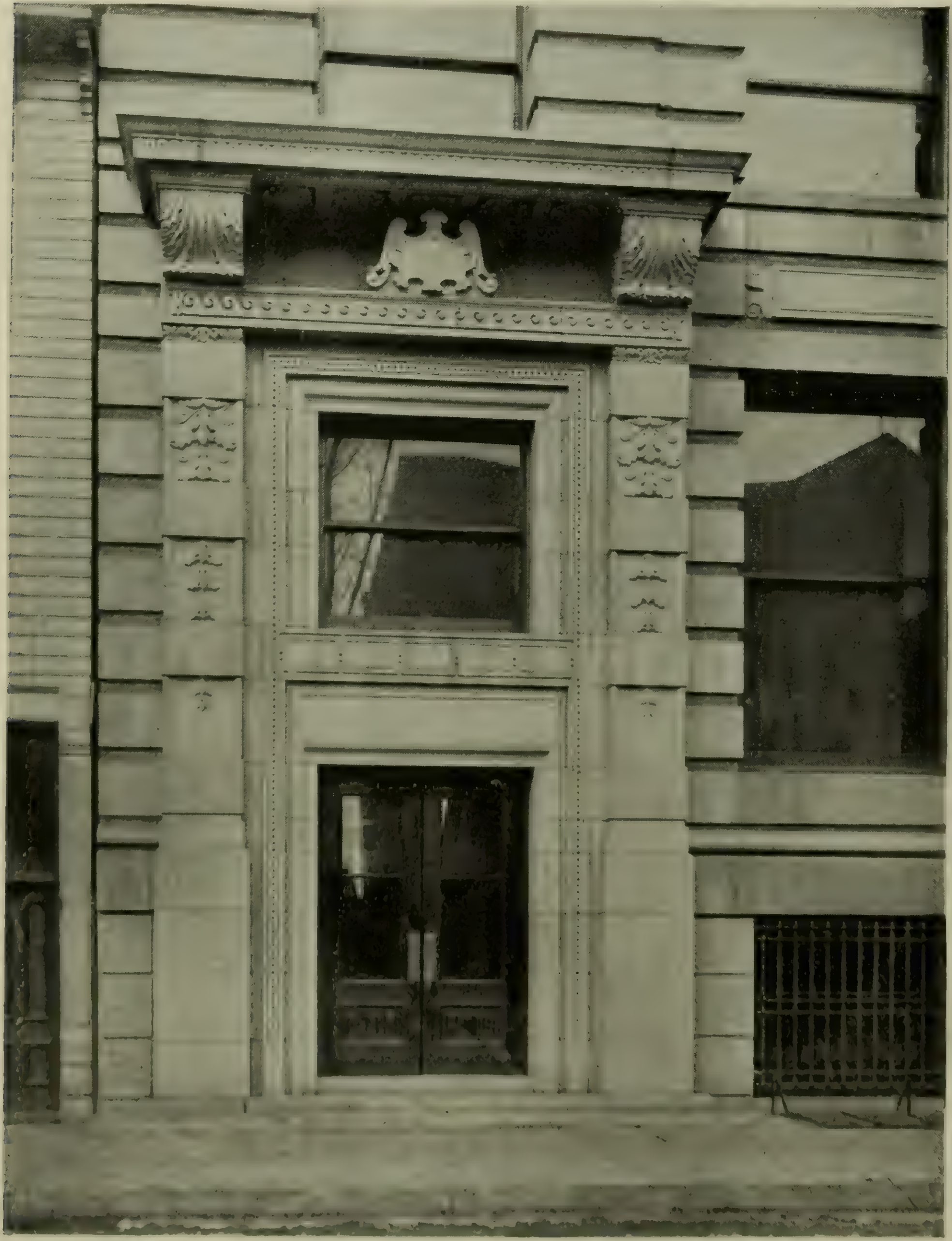
in mass, or in proportion, or in general decorative effect, a great deal of remarkable sculpture is applied to the portico of entrance and the basement of the tower, and some to other parts of the building. This sculpture has an originality of conception which it is hard to find matched in contemporary work; it seems to have been newly designed,—work of our own time. A New York city house at the



DOORWAY IN THE NEW YORK LIFE INSURANCE BUILDING, ST. PAUL, MINN.

Babb, Cook & Willard, Architects.

corner of Fifth avenue and Sixty-third street, and bearing the date 1884, has sculpture upon which the same criticism may be passed. The sculpture which fills the panel in the bay window, and that which invests the high and massive corbels of the same bay-window and the stops of the coves above them, are admirably conceived. If this sculpture is, as it seems to be, a work of our own time, those

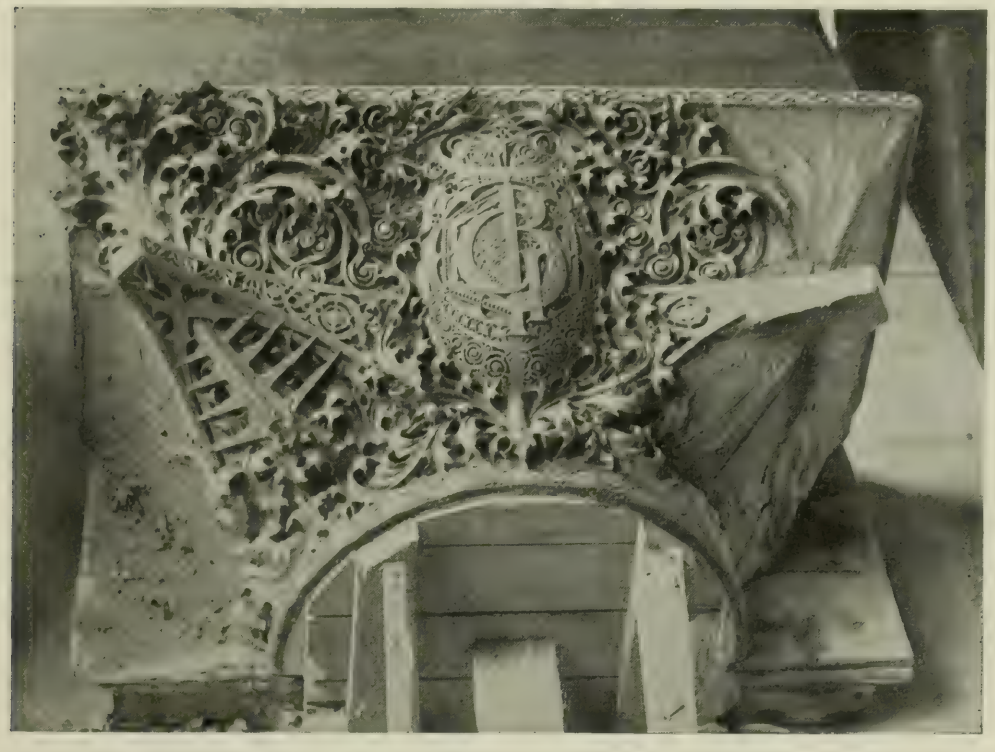


DOORWAY IN THE NEW YORK LIFE INSURANCE BUILDING, MINNEAPOLIS, MINN.

Babb, Cook, & Willard, Architects

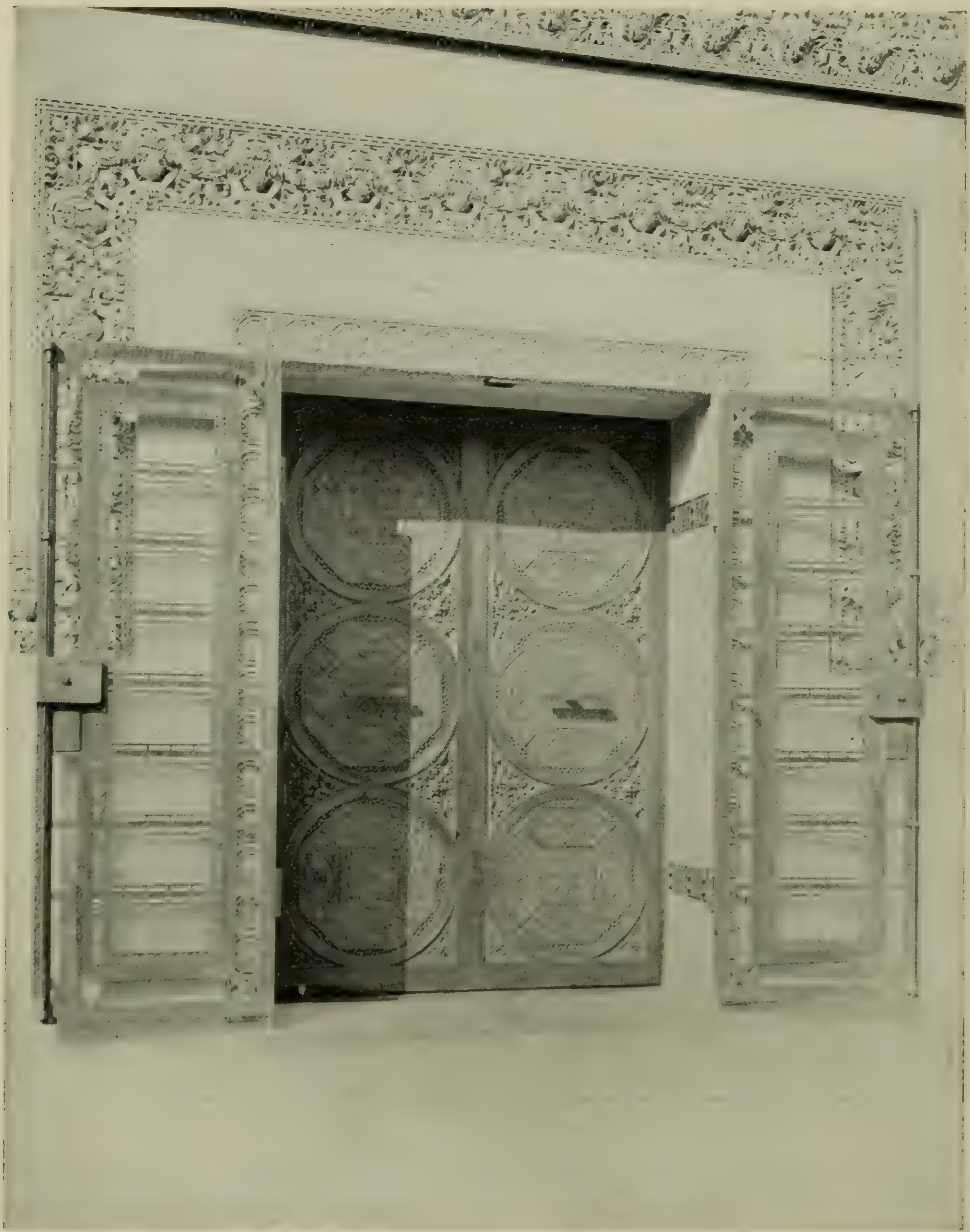
who are responsible for it deserve the thanks of a community which must be getting tired of carving taken bodily from photographs of ancient work.

In some of the sculpture ascribed to Mr. Frank Miles Day similar freshness and apparent originality of treatment are perceptible. There is to be noted in one and the same group of details—as, for instance, in the doorway of the Art Club of Philadelphia--a mingling of sculptured ornament of a recognized ancient style and closely copied from its remains, with the design of more modern treatment, of which it has been a pleasure to speak. A small dwelling-house in Philadelphia, where an arched window fills nearly a whole front of the ground story and a narrow square-headed doorway with a circular light above it completes the group, offers an admirable specimen of Mr. Day's delicate work. Everyone who has to do with decoration knows that the difficult thing to secure is the decorative part. Twenty carvers can model or cut interesting leafage, studied rather closely from nature, and, of these twenty, three or four can carve grotesque and spirited animal form, where one, or not even one, can fill a small or a large panel with scroll-work or diaper in such a way as to give it decorative effect. The house we are considering,



CAPITAL FOR THE GUARANTY BUILDING, BUFFALO, N. Y.

Louis H. Sullivan, Architect.



BRONZE DOORS AND GATES OF THE WAINWRIGHT MEMORIAL, ST. LOUIS, MO.
Adler & Sullivan, Architects.

which is in Walnut street near Sixteenth street, gives evidence that the designer of its sculpture has faced this difficulty, and has allowed his carvers the naturalistic forms which they best understand.

Mr. Wilson Eyre, Jr., has been working in the same direction, using entirely natural forms with conventional line-work and scroll-work and shell-work as mere frame and setting for it. Small houses of his in Philadelphia are adorned with human subjects, modeled with the full modern sense of truth to nature, and yet made to serve as architectural adornment. If any one continues to doubt that Gothic designing might still be good Gothic, even though the sculpture were faithful to nature, in the modern sense ; if the example of Louvain town hall and the great church of Abbeville, or even that of the cathedral at Reims, should not be enough for him,—these pieces of Mr. Eyre's creation would certainly suffice. Particularly to be admired is the square doorway in Walnut street, Philadelphia, where the number 2121 is carved on a scroll which fills the space between two corbels, or, in other words, occupies the whole length of the lintel which these corbels support. Each of the corbels is charged with a seated figure holding a shield. A church club-house has groups of cherubic heads forming bosses from which spring the hood-mouldings of arches. This house, which is in Twenty-second street, Philadelphia, and bears the date MDCCCLXXXVIII has, beside its entrance doorway, a small round window framed by a festoon and two *putti*, this being certainly of less originality of conception than Mr. Day's roundell, but delicately modeled and delicately carved. Several of Mr. Eyre's houses have long and nearly straight scrolls carved at the head of their ground-story wall. These scrolls have supporters in the form of draped female figures of great delicacy, and the combined design is at once ingenious and satisfying, and not at all too quaint to be delightful.

The carved work added sparingly to the buildings of Messrs. Babb, Cook & Willard of New York is remarkable in this respect,—that the accepted forms of fifteenth-century Italian arabesque have been taken as the prototype of what is essentially original designing in the best sense. This is as much as to say that the designer has adopted the Italian renaissance as his style, but has had an ambition above mere copying and an ability which seconds his ambition and has given to his work the stamp of real decorative excellence. The buildings especially under consideration are those of the New York Life Insurance Company at Montreal, at Minneapolis, and at St. Paul ; but the same judgment would apply to other work of this firm, which cannot be specified here.

The above catalogue is far from exhausting the material, even that which is easily accessible. It includes none of the very valuable decorative sculpture of the late firm of Adler & Sullivan of Chicago, which is applied not merely to the exteriors of buildings and their important interior spaces, but also to metal work and other fittings, with singular freedom and appropriateness of design. It includes nothing in terra-cotta or moulded brick. No mention is made of those buildings in which the sculpture, though in itself fine, is badly placed and fails to aid the general design ; or of the more numerous instances of carving which helps the building well enough, though in itself frankly copied from ancient work. The important thing seems to be to insist upon the existence in our cities of a certain amount of really original and, on the whole, admirable decorative sculpture. Students of architectural art who note with surprise the entire absence of sculpture from a building as admirable in its decorative character as the Law School of Columbia College or the group of seminary buildings at Park avenue and Sixty-ninth street ; who miss such sculpture from the stately and massive Dakota building west of Central park, or from the spirited and fantastic Berkshire in Madison avenue, or from the refined Yosemite building in Park avenue ; who wonder how such a church as St. Agnes's Chapel, of Trinity parish, should be carried to completion without a scrap of carving, or how St. Thomas's, or the Collegiate church at Forty-eighth street, should have only the perfunctory capitals and crocketts of the style ; who cannot endure that no sculpture should be given to such sumptuous private houses as half a dozen in upper Fifth avenue,—such persons may be comforted by the knowledge that a great deal of good sculpture of the decorative sort has come into existence within the decade. It is scattered thinly over a vast tract of country, but it is there ; and the important question now is how there can be made possible the production of more, very much more, of it.

THE FREE-PORT OF COPENHAGEN.

By P. Vedel.

LAST summer, when the German emperor opened the North-East Sea canal, greeted by the cannons of all the navies in the world, little Denmark was expected to tremble lest the Baltic trade should be diverted from the sound to this new route. Nothing of the kind occurred, however. Anticipating that some danger might arise from this source, the Danish government had built a new harbor at Copenhagen, and, half a year before the inauguration of the canal, Copenhagen Free-port had been formally opened. No flourish of trumpets or salvo of artillery announced this fact to the world, for it was not a military undertaking. The government, the city, the board of trade, and the people had united in a determination to make the Danish capital more than ever a distributing center for the Baltic. And, with united efforts, they had built a harbor second to none in the world and provided with the newest and most improved accommodations for the loading and unloading of vessels, storage of goods, etc.

A *free-port* has been described as a piece of foreign territory in the inland. It is a harbor basin with a certain land area, surrounded on all sides by high fences which constitute the boundary between the free territory and the inland. Within the enclosed area vessels can unload their merchandise and store it in the warehouses free of all tariff duties or inspection of custom-house officers. Factories may be located there and may use imported, dutiable raw materials without paying any duty ; they may export their manufactured products, or send them inland ; in the latter case the duty must be paid. Whatever passes the boundary line must pay all dues as if coming from a foreign country. But what is stored in transit only, what is lost by leakage and evaporation, waste of raw materials from the factories, etc., pay nothing. The freedom of a free-port usually refers to tariff duties only ; but in Copenhagen it is really a free harbor, all harbor dues having been done away with. It is, therefore, one of the cheapest harbors at which a vessel can call. The Copenhagen Free-port administration in a recent pamphlet (French), gives an account of the progress of the work and the different constructions of which the writer makes free use.

The annexed diagram shows the new harbor. The boundaries of the free territory are indicated by heavy lines. Outside these, or belonging to the inland, are the New Limekiln dock, the Pleasure Craft basin, and the east quay of the eastern pier. The free-port consists of a north basin, a central basin, and a south basin, the depths of water being from 24 to 30 feet, which is as much as in the North-East Sea canal and sufficient for the largest vessels. Between the central and the south basins is a berth for the steam ferries which connect Sweden with Denmark. The total land area enclosed is 89 acres, with a water area of 59 acres and a docking 12,350 feet long. It is enclosed by a double iron fence 7,620 feet long; the outer fence is 9′ 3″ high and the inner 8′ 5″, and they are 6 feet apart, thus forming a patrolway for the custom-house officials and preventing smuggling. A railroad track is fenced off through the old fortress and the park, so as to connect the free-port with the old harbor of Copenhagen. The park around the harbor for pleasure-boats, and east and north of the fortress, covers about 40 acres. Its walks are carried on bridges over the railroad tracks, and the seashore promenade extends out on the eastern pier over the roof of a low warehouse. To facilitate the entrance and departure of barges from the free-port, as well as to produce a light current through the latter, a *barge-canal*, 300 feet long by 30 feet wide with 9 feet of water, is cut through the south end of the east pier. It is crossed by five bridges, and closed at night by chains.

The free-harbor law was passed in March, 1891, and work commenced at once. The Copenhagen Harbor administration excavated the basins and dredged the entrance channels, built breakwaters, quay-walls, fences, roads, and sewers, and graded the ground. The Copenhagen Free-port company, which holds the privilege of operating the free-port for eighty years, built the warehouses, grain elevators, power house, and administration building, laid the railroad tracks and water-mains, and furnished the cranes, electric installation, etc. The railway board constructs the pier and berths for ferries, with depot etc.

The north basin was dredged by powerful chain-bucket dredges, but the *excavation* of the central basin and south basin was done by exclusion of the water. Coffer-dams were built out in the sea around the territory, which was originally covered with water; by a cross-dam near the ferry-berths the central basin was separated from the south basin, and each of the two sections was thus worked independently of the other. The south section covers an area of 49½ acres, and was pumped dry in 68 days; four centrifugal pumps delivered in that time 163,000,000 gallons of water. After that one pump worked daily 11¼ hours to keep the water out. The north section covers 61 acres; three centrifugal pumps pumped in 20 days 596,000,000 gallons, and after that 16½ hours' work of one pump was needed daily to keep the water out. On the south section, where the contract price was 25 cents per yard excavated, 670,000 cu. yds. were moved in 419 working days, or 1600 cu. yds. per day (maximum per day, 3,500 cu. yds.); the digging was done by a chain-bucket excavator of the Lubeck type. On

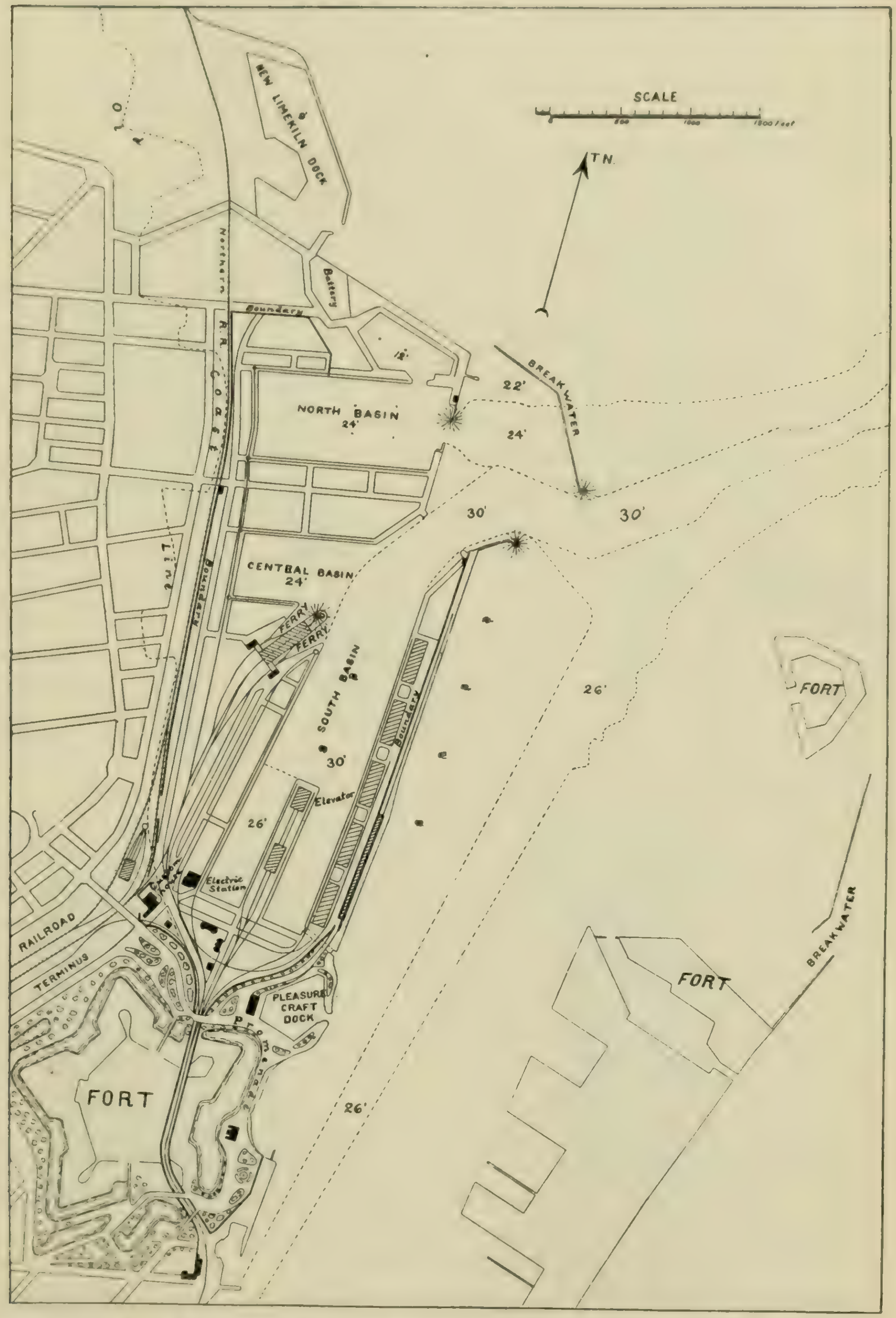
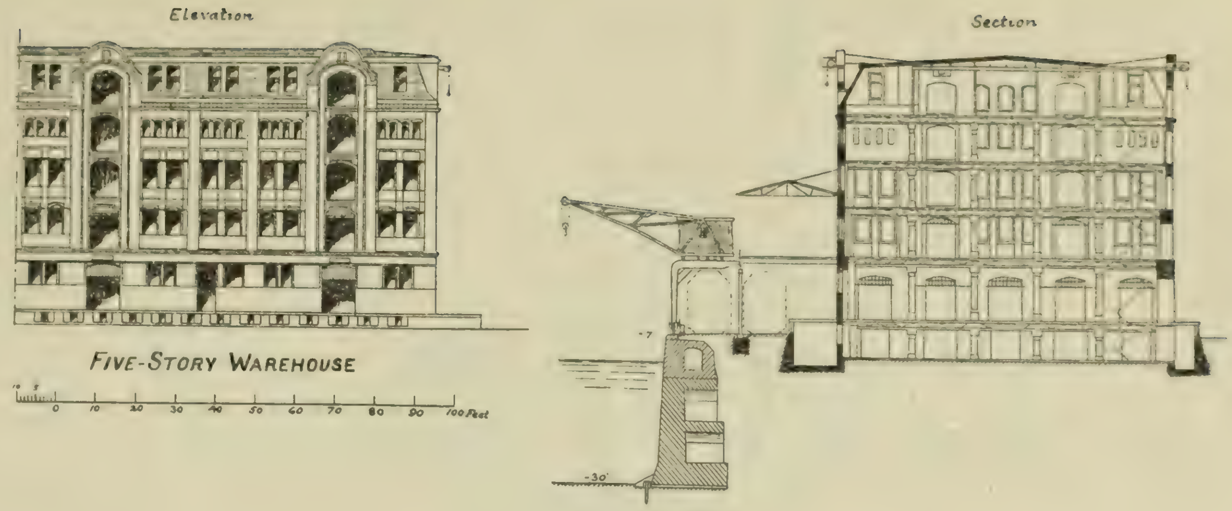


DIAGRAM OF THE FREE-PORT. THE BOUNDARY IS INDICATED BY THE HEAVY LINE.

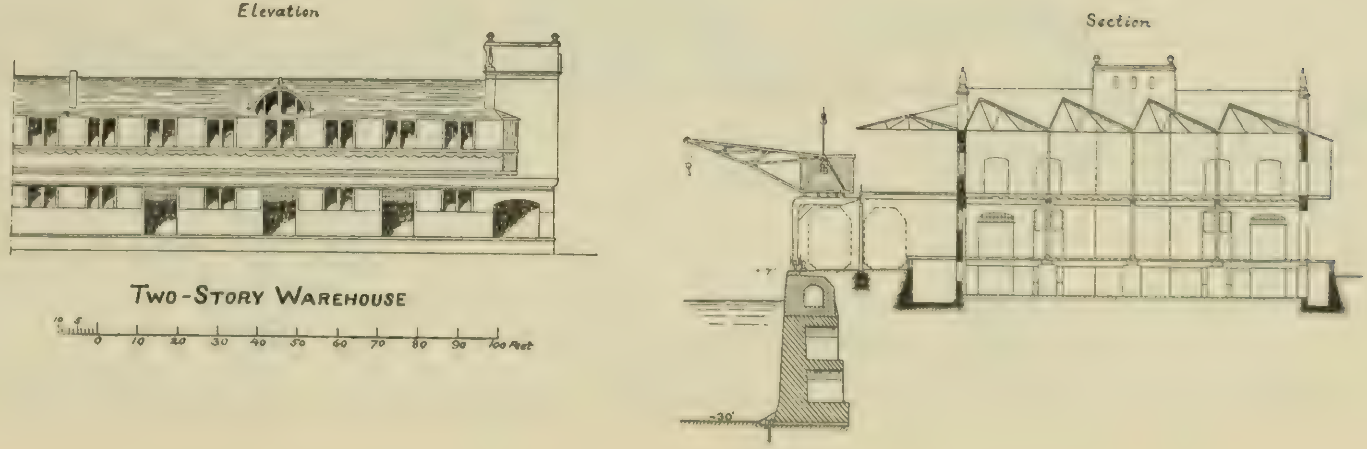
the north section the contract price was 23 cents per yard, and 765,000 cu. yds. were excavated in 357 working days and 50 nights, or 1,880 cu. yds. per day (maximum in 24 hours, 5,890 cu. yds.); the digging was done by one Lubeck excavator with a daily average capacity of 1,159 cu. yds. and one Belgian chain-bucket excavator with a capacity of 697 cu. yds. in 10 hours. The soil consists of clay and sand with boulders and fragments of the underlying limestone bedrock.

Three types of docking have been used. Wooden bulkheads of a very substantial construction were built so that the part above water could easily be renewed. For protection against teredos the piles are all sheeted with iron plates. In 24–26 feet of water the contract price is $36.40 per lin. ft., and about 710 feet B. M. enter into the construction per lin. ft. The solid quay walls consist of concrete from the bottom to 3′ 9″ below water, and granite masonry above. On the backside the concrete forms arches between counterforts, and through the masonry is formed a tunnel which serves as a receptacle for the gas- and water-pipes, electric-light wires, electric-power cables, etc. The wall is 38½ feet high, has an average thickness 3-10 of its height, and contains 452 cu. ft. per lin. ft. Its cost was $110.73 per lin. ft. Every 260 feet it has a vertical joint through its whole height; this was done to prevent it from cracking, as the ground was found to settle unevenly. The third type is a combination of the two first,—*i. e.*, the upper part of the masonry wall resting on the under part of the wooden wall. Its cost was $76.28 per lin. ft. In order to protect the timber against the teredos, Monier plates (6′10″ × 3′3″ × 2⅓″ with net work of 0″.20 and 0″.28 iron wires, B. W. G. No. 6 and No. 2) were fastened to the front of the main piles, and the space between them and the planking was filled with concrete. At the foot of the piles a row of sheet piles was driven, and a toe of concrete was formed to prevent the earth from being washed out by steamers moving their propellers. Not until all the walls were built was the water let into the central and south basins through a 12″ pipe and a 16″ pipe. It took 39 days and 457,000,000 gallons of water to fill the two sections in this manner.

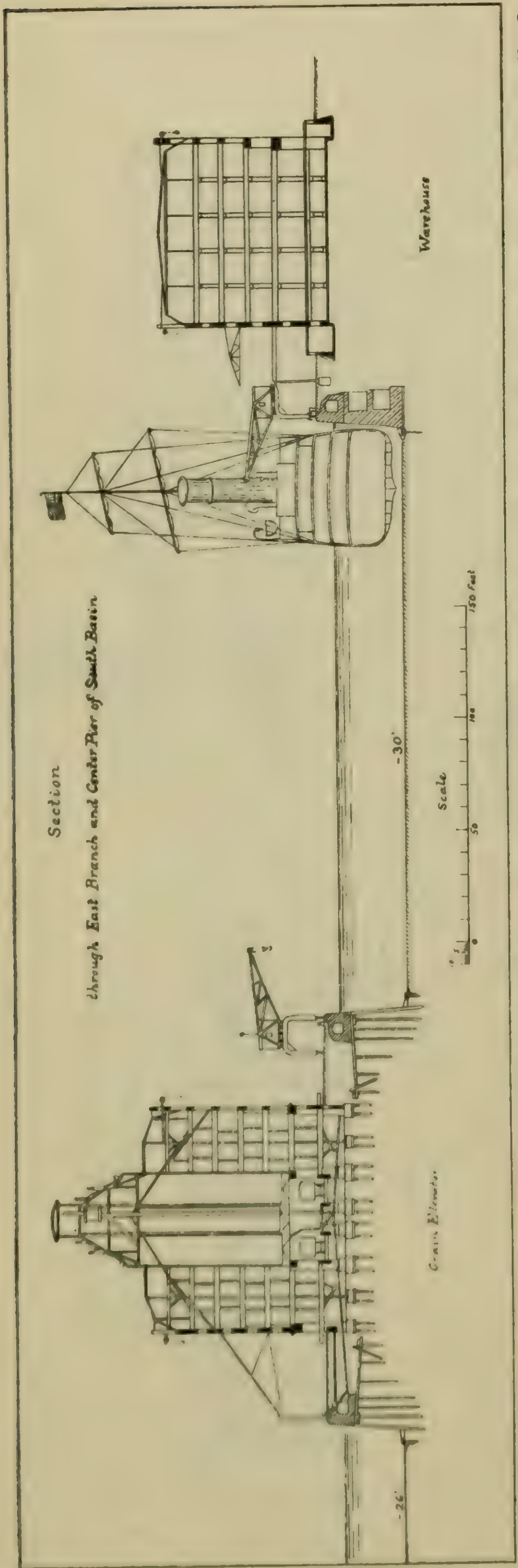
The warehouses are all fire-proof with I beams and cast-iron columns covered with Monier plates, and asbestos layers between floorings. They are 309′ × 82′, some of them two stories and others five stories high. The basement is 8′ high, first floor 14½′, second 11⅓′, third and fourth 10¼′, and the top story 11⅓′. The first floor is calculated for a load of 460 lbs. per sq. ft., the second, third, and fourth floors for 300 lbs., and the fifth for 200 lbs., the weight of the floor not included. Each warehouse has stairways, six elevators, and six cranes, all worked by electricity. At a level with the second floor an



FIVE-STORY WAREHOUSE



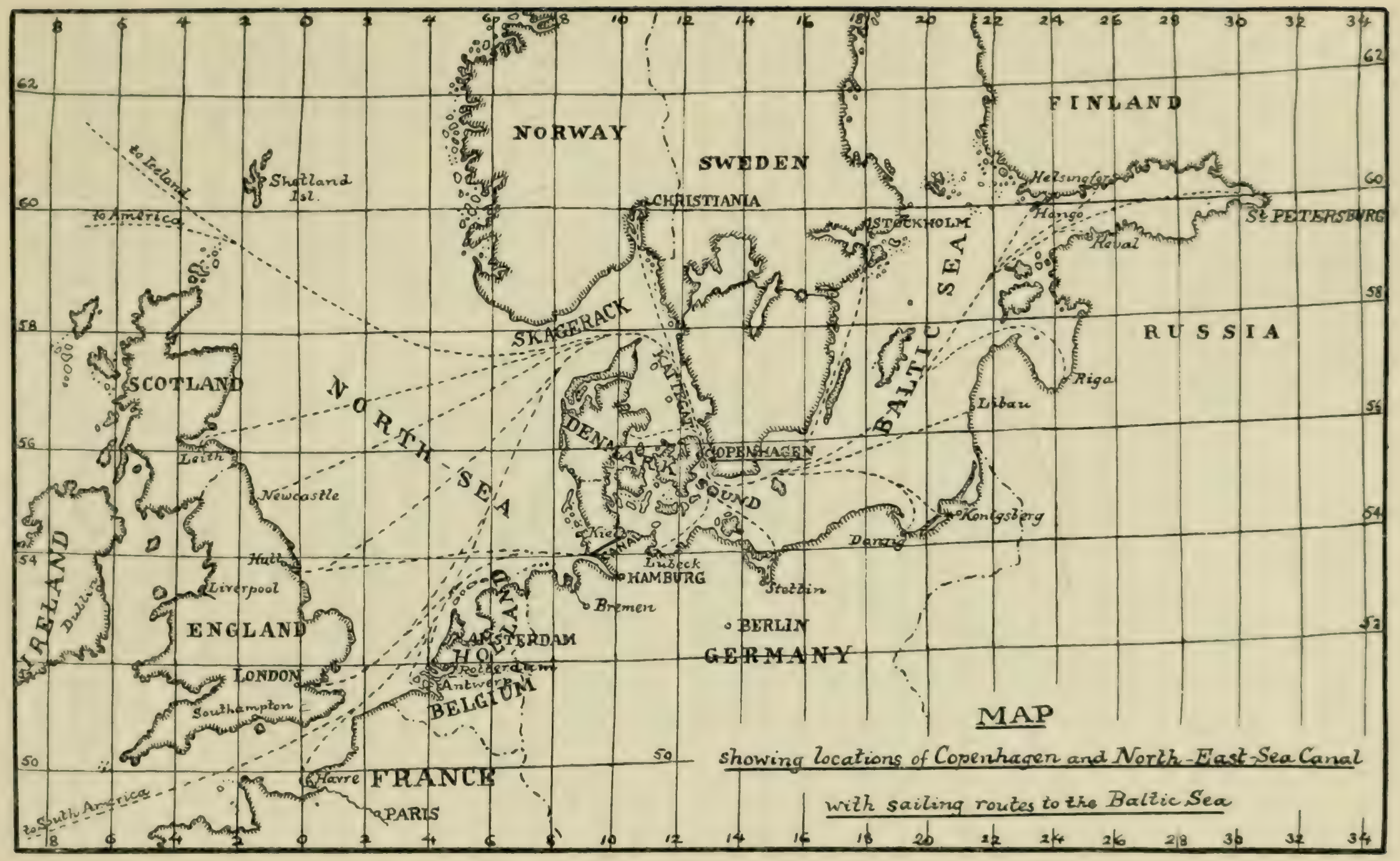
TWO-STORY WAREHOUSE



elevated structure on the quay-side of the warehouses connects them so that goods can be transported from one to another by truck-cars.

On the central pier is a grain elevator 164′ × 102′ × 128′ high. It is longitudinally divided into three sections. The two outer ones have a basement and seven floors for storage of grain, whereas the middle section has thirty-six wooden bins in three rows, 67′ high, each group of eighteen being surrounded by Monier walls. This warehouse is provided with the most improved machinery for handling and storing grain; railroad cars can run in under the bins, and it is calculated to unload from 2,000 to 2,500 tons within 36 hours after the arrival of the vessel at the quay.

The harbor entrance is well protected by breakwaters and the small islands which enclose the inner roads of Copenhagen. The east breakwater between the forts is built in 10 feet of water, of riprap and piles. The north breakwater, which has attracted wide attention and was described in *Engineering News* (July, 1894), is built in 10 to 24½ feet of water. It rests on a sand and riprap foundation, and consists of one or two tiers of concrete blocks below water and a solid granite wall to about 6 feet above water. It is on the outside backed by sand and gravel, with the slope protected by loose stone. The blocks are 10′3″ high by



MAP

showing locations of Copenhagen and North-East-Sea Canal

with sailing routes to the Baltic Sea

10′8″ wide by 8′3″ long. In order to make them light enough to be handled by the floating derrick, and heavy enough, when in place, to resist the waves and the ice thrust, they were made hollow, and afterwards filled with sand and stone. Thus, when handled, their weight was 39 tons, whereas in place they weigh 53 tons. Their two sides, transverse to the length of the breakwater, are formed of Monier plates (2⅜″ thick with network of 0″.20, 0″.28, and 0″.3 8 iron wire) placed one foot from the end of the two other sides ; the space thus formed between two adjoining blocks is filled with a special little keyblock. The construction of this breakwater took nearly three years; in it were used 265 large blocks ; the greatest number put in place in one day was six.

A notable feature in all the constructions is the extensive use of Monier plates of iron network embedded in cement mortar (1:3, which has the same coefficient of expansion as iron).

The entrances and channels which lead to the free-port are all marked with lights and buoys, and vessels can make the harbor in any stress of weather. The sound has no tides, and the depths there and in the basins are sufficient for the largest merchant vessels afloat. A moderate current prevents the formation of ice, and the sound is hardly ever ice-bound ; in fact, during the last fifteen years a steamer has made at least one daily trip between Copenhagen and Sweden.

It is certainly a costly experiment to build such a harbor and suddenly increase the existing dock frontage by about 33 per cent., or three miles. It costs still more to make it a free-port and build guardhouses at all the entrances, as well as custom-houses and fences, and maintain a large staff of custom-house officers to watch the boundary night and day. But the nation has determined, at any cost, to make Copenhagen the Hamburg of the north, where goods may be stored and whence they may be distributed to surrounding countries by vessels suitable for the shallow waters of the Baltic. And now it offers to commerce every inducement : a commodious, deep, and practically ice-free harbor, provided with the most improved machinery for the quick despatch of vessels ; modern, fire-proof warehouses, grain elevators, provision stores, etc. ; and freedom from all harbor dues and customs dues, with all the delay and annoyance connected therewith. It is safe to say that not a very large percentage of the 16,500,000 tons that now annually pass the sound will take the new route through the Kaiser Wilhelm canal. The old wooden sailing vessels of the large Swedish, Russian, and North German timber fleet cannot afford to pay the high canal dues. Nor would any vessel bound for the United States or Canada, without any saving in distance, prefer the dangerous navigation of the Elbe and the English channel to rounding the Skaw and the north of Scotland.

OPPOSITION TO INVENTIONS.

By William C. Dodge.

ONE of the most remarkable things in the history of mankind is the opposition to the introduction of inventions and improvements which has existed from the earliest times, and still exists to some extent.

From the time when the earth was believed to be flat, and Galileo was denounced and imprisoned for asserting, in accordance with the theory of Copernicus, that the sun was the center of the planetary system, and that the earth had a diurnal motion of rotation, this opposition to new ideas has existed, and been manifested in the grossest outrages upon, and persecutions of, the originators and advocates of the new ideas. This has been true of inventions and improvements in the arts and sciences, as well as in governmental and religious improvements or reforms.

Much of this was due to the existence of the prevailing doctrine of the "divine right" of rulers and the arbitrary power exercised by them, and to the claim of superior wisdom and infallibility made by the then dominant church, supplemented and rendered possible by the ignorance and helplessness of the masses.

Besides, human nature seems to be subject to the same law as moving bodies; it moves always in a direct line when once set in motion, unless interfered with by a power sufficient to deflect it from its course. In the arts and sciences, as in politics and religion, men prefer to remain undisturbed, and naturally resent any interference with their settled beliefs and habits. They look with suspicion on new suggestions or ideas, and especially such as, in their ignorance, they think will interfere in any manner with their present interests; and hence the tendency to continue in the old ruts, and violently oppose improvements or changes, and to denounce inventors as "cranks."

History shows that the great improvements in the arts and sciences have had their development only since free governments have been established, and general education introduced; and it is where these exist in their greatest perfection that the greatest advance has taken place.

In the United States, where there is the greatest freedom in governmental and religious matters, there has been the greatest advance in inventions. The growth and development of our manufacturing and agricultural interests, which is due to inventions fostered by our patent system more than to any other cause, has been marvellous, and excites the astonishment of the world. Under the benign influence of this system, in a single century, we have grown from a cluster of scattered settlements, mostly along the Atlantic seaboard, with a population of less than four millions, to a compact and powerful nation of nearly seventy millions; have increased our national territory from 830,000 to 3,314,220 sq. miles; have subdued the forests and built up the whole country from ocean to ocean; and have built more miles of railroad, and established more post offices, than all other nations combined. We have grown and prospered as no other nation has, until to-day we do one-third of the world's manufacturing, one-third of its mining, one-fifth of its farming, and possess one-fifth of its wealth.

With such an illustration of the benefits of our patent system, one would suppose that opposition to inventions would long since have ceased; but unfortunately, while it has greatly diminished with the growth of intelligence and universal education, it still exists.

As illustrative of this spirit of opposition, it may be interesting to cite a few instances.

When, in 1807, Papin of France, the inventor of the digester in universal use for paper-making and many other purposes, and also of the lever safety valve, made a small steamboat and ran it down the river Fulda, the ignorant boatmen, who, like some of the laboring men of the present day, thought it would injure their business, seized and destroyed it.

So too, when Jonathan Hulls patented his steamboat in England in 1736, he was laughed at and ridiculed in every conceivable way. One paper published the following doggerel in reference to him:

Jonathan Hulls,
With his patent skulls,
Invented a machine
To go against wind and stream,
But he, being an ass,
Couldn't bring it to pass,
And so was ashamed to be seen.

When Jacquard invented his loom, which was so wonderful that the great Arnot, French minister of war, caused him to be brought into his presence and said to him: "Are you the man who can do what the Almighty cannot,—tie a knot in a stretched string?" there was the strongest opposition to its introduction, culminating in a mob of the silk weavers, who took it from his house into the streets, broke it up, and burned the fragments.

It was the same with Hargreaves in England, when he invented his spinning-jenny in 1763. He was persecuted by his fellow workmen, who seized his machine, broke it in pieces, and drove him from his native town.

That invention, with the improvements of Arkwright and Crompton, and the invention of the cotton gin by Whitney, who was outrageously defrauded of his rights, have changed the entire art of producing woven fabrics. Indeed, so far as the cotton industry of the world is concerned, they may be said to have created the industry, which to-day gives employment to millions, and has so immensely cheapened the product that it is used the world over.

This opposition to and unbelief in the possibility of the success of inventions has not been confined to the ignorant alone, but has been shared by many educated and even great men. When it was proposed to build a railroad in the United States, Chancellor Livingston, one of the greatest men in the State of New York, published a letter in which, as he thought, he demonstrated the utter impossibility of the proposed undertaking. His reasons were, first, that it would require a massive sub-structure of masonry the whole length of the road, and that would be so expensive that it would not pay ; second, the momentum of such a moving body as a train of cars would be so great that the train could not be stopped until it got several miles past the place ; and, third, no one would want to risk his life flying through the air at the rate of 12 or 15 miles an hour.

So, too, Daniel Webster expressed grave doubts as to the possibility of railroads, saying, among other things, that the frost on the rails would prevent the train from moving, or from being stopped if it did move.

When the Baltimore and Ohio Railroad was first opened from Baltimore to Ellicott City, an excursion was given to an invited company composed of prominent citizens, among whom was Mr. Seaton, editor of the Washington *Intelligencer*.

In describing the trip, which was by cars drawn by horses, on the old flat or bar rail spiked to wooden stringers, he said they were in mortal terror, lest some of the cattle feeding by the roadside should get on the track and throw them off. In winding up his long description, he said that he thought it possible that it might be of use for the carriage of goods, as on a flat, smooth surface, like the rails, a horse could haul much more than it could on an ordinary road ; and, as to travel by rail, he said that he thought it possible to attain a speed of 12 miles an hour, which would be as fast as anyone would ever want to ride !

Now, when we have in the United States about 220,000 miles of railroad tracks,—an amount so great that it would take a locomotive 4½ months, travelling at the rate of 60 miles an hour and 24 hours per day, without a single stop, to traverse it,—and when on some the regular speed is 1 mile per minute, and for short runs even more, one can hardly believe that such ideas were ever entertained, least of all by men such as those mentioned.

All this and much more is the result of invention ; for, as was well said by Senator Platt, "a railroad, from the steel rail to the top of the smoke stack, from its locomotive head-light to the signal lantern on the platform of the last car, is but an aggregation of inventions." Still, the history of the world is full of such incidents and "doubting Thomases." They stand like mile-posts along the pathway of every art and science, and serve to mark the progress of mankind in civilization.

Probably no class of men make so many unpatented inventions as civil and mechanical engineers. There is scarcely a single great mechanical structure or work of any kind, in which they do not invent or devise new means and methods for expediting the work and improving the structure ; and these works, dotting the face of the earth, are so many monuments to their inventive skill and ability.

When Murdoch invented or discovered a means for producing illuminating gas, no less a man than Sir Humphry Davy ridiculed the idea of using it for lighting purposes, and said, if it was to be used for street lighting, they would have to use the dome of St. Paul's for a gasometer. Sir Walter Scott made clever jokes about "sending light through street pipes" and "lighting London by smoke," but subsequently had his house lighted by it. Wollaston, a scientific man, said "they might as well attempt to light London with a slice from the moon." It is but a few years since the scientists of Europe demonstrated mathematically that the electric current could not be divided for incandescent lighting ; but to-day the contrary is demonstrated by millions on millions of incandescent lights, illuminating every spot where civilized man resides.

But the strangest of all things in this connection is the fact that, even in this enlightened age, there are men who still insist that inventions are injurious. It is not many years since that, in a paper published at the national capital, there was the statement that the invention of the steam engine and the sewing machine were two of the greatest curses that ever befell mankind !

It is, moreover, a matter of history that in certain sections of this enlightened land prayers were fervently offered in churches beseeching that the wickedness of the newly invented sewing machine, which, it was supposed, would rob the sewing women of their means of obtaining a living, might become apparent, and its promoters be stricken by a conviction of their wrong-doing in making it, and thus be told by Heaven to desist from its manufacture.

As illustrating the difficulty of securing the adoption of new ideas, I may mention a more recent instance. When the war broke out in 1861, I spent much time in the effort to induce the government to adopt breech-loading guns and metallic cartridges, but it took 3 years to secure the former, and the latter were not adopted until 1868.

In 1861 or 1862 the president of Sharpe's Rifle Co. came to Washington to secure a contract to furnish its rifle for the Berdan sharp shooters. I endeavored to convince him of the advantages which would result if it would adopt the metallic cartridge and reduce the caliber of its gun, but in vain. He said the metallic cartridge would never be adopted, and the chief of ordnance, in April, 1864, told me that the government would never adopt it. Now both have been adopted the world over.

This spirit of opposition exists to-day to a greater or less extent among the labor unions, whose members, without investigating the subject, are made to believe that labor-saving machinery deprives them of employment, or at least will lessen their wages. just as the silk weavers of Lyons thought in regard to Jacquard's loom, and as the spinners of Lancashire thought in reference to Hargreaves's spinning-jenny.

This belief exists because of a want of knowledge of the facts on the part of these men, and because it has been fostered by demagogues for political purposes to secure the votes of these men. It is only a short time since a United States Senator, in a public address, asserted that the fact that so many men had been thrown out of employment during the past 2 years was due to the introduction of labor-saving inventions or machines.

It is no doubt true that, when a new invention is introduced which revolutionizes some particular art or branch of business, it at first decreases the number of persons employed in that particular line ; but that is only temporary, for in a short time the result is a cheapening of the product, a greatly-increased demand for it because of this cheapening, and then necessarily an increased demand for laborers in that line, and almost universally at increased wages.

The statistics of the country show this to be true beyond the possibility of question. The records of the labor bureau show that from 1860 to 1880, the most prolific period in this country of inventions, and the most intensified in all directions of their introduction, the population increased 59.51 per cent., while in the same period the number of persons employed in all occupations—manufacturing, agriculture, domestic service, and everything—increased 109.87 per cent.; and in the decade from 1870 to 1880 the population increased 30.08 per cent., while the number of persons employed increased 39 per cent.

As the commissioner of labor says : "An analysis of these statements shows that the increase of the number of those engaged in manufacturing, mechanical, and mining industries,—those in which the influence of inventions is most keenly felt,—for the period from 1860 to 1880, was 92.28 per cent., as against 59.51 per cent. increase of population." And he adds: "If statistics could be forcibly applied to show the new occupations brought into existence, I believe the result would be still more emphatic."

As shown by the investigation of a Committee of the Senate, wages have increased 61 per cent. in the United States since 1860. And, as all know, during that same period the cost to the people of nearly all manufactured articles has been decreased in as great if not a greater ratio. As with manufacturers, so with farming. As a recent writer has well said, "the use of patented machinery has so changed agriculture that there is more propriety in saying that we manufacture crops than in saying that we raise them." And still another writer says: "We use implements that cheapen the cost of production, and make the labor of harvesting like the sport of the fairy books."

According to the statements of Mr. Larimore to the foreign commission from the World's Fair visiting Dakota, he had, "by the adoption of improved machinery and methods, reduced the cost of raising wheat to $4.50 to $5.00 per acre. The cost of harvesting, the most laborious and expensive feature of farming abroad, was there reduced to half a cent a bushel; and yet, notwithstanding this extensive use of machinery, it was impossible to secure all the hands needed at from $3 to $4 per day."

While most people have the idea that inventions have mainly benefited the manufacturing industries, it is susceptible of demonstration that they have benefited our agricultural industries nearly, if not equally, as much.

In speaking of the condition of the United States, a recent English observer says:

"America has for many years enjoyed an amazing degree of prosperity, so much so indeed, that, to use the eloquent words of Edmund Burke, 'generalities, which in all other cases are apt to heighten and raise the subject, have here a tendency to sink it. Fiction lags after truth, invention is unfruitful, and imagination cold and barren.' The United States has 65,000,000 people, who spend more on dress than any other people on the face of the earth," and who, he might have added, enjoy more of the comforts of life in all directions than any other people on earth.

"Again," says he, "in spite of the wonderful development which has taken place, the possibilities, I might say the certainties, of future progress were marvellously illimitable."

REVIEW OF THE ENGINEERING PRESS

WITH A DESCRIPTIVE INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE AMERICAN AND ENGLISH ENGINEERING AND ARCHITECTURAL JOURNALS.

INTRODUCTORY

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles o the month which are deemed of most importance ; (2) to supply a descriptive Index to the leading articles published currently in the engineering, architectural and scientific press of the United States, Great Britain and the British Colonies; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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Am. Chemical Journal. *b-m.* $4. Baltimore.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Archæologist, The. *m.* $1. Columbus, O.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $6. New York.
Arena, The *m.* $5. Boston.
Australian Mining Standard. *w.* 30*s.* Sydney.
Banker's Magazine. *m.* 18*s.* London.
Bankers Magazine of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6*s.* London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick. *m.* $1. Chicago.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Geographical Soc. *q.* $5. New York.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $1.50. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Contemporary Review. *m.* $4.50. London.
Cosmopolitan, The *m.* $1.20. New York.
Domestic Engineering. *m.* $2. Chicago.
Electric Power. *m.* $2. New York.
Electric Railway Gazette. *w.* $3. New York.
Electrical Age. *w.* $3. New York.
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York

Electrical Engineering. *m.* $1. Chicago.
Electrical Industries. *m.* $1. Chicago.
Electrical Plant. *m.* 6*s*. London.
Electrical Review. *w.* 21*s*. 8*d*. London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s*. London.
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Engineer, The. *s-m.* $2.50. New York.
Engineer, The. *w.* 36*s*. London.
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Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s*. London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fairplay. *w.* 32*s*. 6*d*. London.
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Forester, The. *bi-m.* 50 cts. May's Landing, N.J
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6*s*. 6*d*. Birmingham.
Gas World, The. *w.* 13*s*. London.
Geological Magazine, The. *m.* 18s. London.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s*. 8*d*. London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s*. 4*d*. London
Iron & Steel Trades' Journal. *w.* 25*s*. London
Iron Industries Gazette. *m.* $1.50. Buffalo.
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s*. London
Journal of the Society of Arts. *w.* London.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9*s*. London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore

Marine Engineer. *m.* 7*s*. 6*d*. London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m.* $1. New York.
Mechanical World. *w.* 8*s*. 8*d*. London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
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Mining Industry and Review. *w.* $2. Denver
Mining Journal, The. *w.* £1. 8*s*. London.
Mining World, The. *w.* 21*s*. London.
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Overland Monthly. *m.* $3. San Francisco.
Paving & Munic. Eng. *m.* $2. Indianapolis.
Plumber and Decorator. *m.* 6*s*. 6*d*. London
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
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Sanitary Record. *m.* 10*s*. London.
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Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, New York.
Social Economist. *m.* $2. New York.
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Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Am. Ins. Electrical Eng. *m.* $5. N Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5*s*. London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.

ARCHITECTURE & BUILDING

See also "Civil Engineering" and "Domestic Engineering."

Municipal Control of Buildings.

EACH year appears to increase the legal restrictions which surround building operations in great cities. Every large city now has its building law, chiefly dealing with questions relating to safety of construction, rights of owner and builder, prevention of fires, maintenance of certain standards of building, and similar limitations of a constructive or sanitary or physical nature. But the architect is no longer satisfied with limitations such as these. It is one of the penalties we must undergo from the diffusion of architectural knowledge that it is now possible to exert public opinion on questions that once were not so much as thought of, but which are now gravely discussed and determined, not by the architect alone, but by eminent personages of no architectural knowledge at all. So far as this country is concerned, little has been done in the way of municipal control of buildings and esthetic matters, save in the regulation of heights of buildings, of which has been said of late a great deal measured by words, but little measured by facts or common sense. A further "advance" was attempted in the effort to place a bill requiring the licensing of architects upon the statute-books of the State of New York, in the winter of 1895, as though the art of architecture could be improved by legislative enactment!

In foreign countries legal restrictions concerning building in cities are much more stringent than in America, and a paper by Dr. G. B. Longstaff, of the London county council, read before the Architectural Association of London in November last, and printed in *The Builder* (November 30), affords some interesting insights into English views on this subject that may be of interest to American students of architectural ideas at this time. A few years ago, for example, some enterprising tradesmen in London conceived the idea of erecting huge wire screens upon the tops of their buildings, with legends setting forth the name and business of their proprietors. One was rash enough to project a sign against the dome of St. Paul's. A huge outcry was raised, and, as a result of the agitation, no more signs of this sort were permitted to be built, and those already up were ordered down. Perhaps this was a real artistic advance, but it certainly shows a remarkable state of public opinion that such a subject could be made a matter of general discussion.

More horrible than this, if we are to accept Dr. Longstaff's opinion, was the proposal of that national British joker, *Punch*, to erect a cistern for a "sprinkler" upon lofty steel legs on the top of the building, "for all the world like a colossal spider. But," adds the doctor, "the council crushed this new form of vermin, ere it had emerged from the egg." We have not yet reached this point in America, and, while it may indicate an advance in municipal improvement, we are not yet ready for such radical restrictions upon freedom of action. Those citizens of NewYork who are privileged to view the top of the Havemeyer building from the rear must recognize the unartistic effect of the various tanks, cisterns, and other mechanical contrivances gathered upon its roof. A more unshapely mass does not exist in the metropolis; yet would our constructionists, who maintain that every necessary part of the building shall be freely expressed in their construction, maintain it would have been better to have enclosed all these within a screen of wall? Truth might have been sacrificed by such a method, but certainly art would have gained by it.

A more notable instance is the building of the American Surety Company in New York. This is a twenty-one-story building on a lot about eighty-five feet square. Very wisely, and quite remarkably as an instance of the heeding of artistic effect in purely commercial structures, the design has been carried around all four sides of the building, which thus assumes the natural form of a tower. Quite as happily, also, the roof is perfectly flat, the cisterns and tanks being kept within the line of acroteria with which the cornice is crowded. Here we have a notable case of the best artistic arrangement without the interposition of a compelling law, and resulting solely from enlightened and thorough artistic knowledge and a fine appreciation of the fitness of things. When such results can be accomplished by knowledge alone, why add laws compelling such action, which might not be possible in every case without undue hardship?

Such, certainly, would seem the more reasonable course. Nevertheless, it is evident that in this unoriginal age of architecture, which so sadly needs every encouragement to freedom, more and more restrictions are being laid upon building.

A Painter on Scenic Art.

No Englishman in recent years has given greater attention to the artistic phases of scenic art than the celebrated painter, Professor Herkomer. Not only has this gentleman published several articles on this subject in the English magazines, but he has constructed a theatre of his own, in which he has put his experimental knowledge to practical use. It is not too much to say that he has carried his researches far beyond anything American audiences are familiar with, his naturalistic effects and mechanical appliances being much superior to those employed by Sir Henry Irving, whose stage pictures are unquestionably the finest yet presented to American audiences.

An extended paper on "Scenic Effect" was read before the Architectural Association in London in December (*The Builder*, December 14) by Professor Herkomer, in which he recapitulated his theories and explained his ideas. Much of his paper was naturally concerned with the production of artistic effects on the stage itself, but the architecture of the audience-chamber received some notice. The two principal defects referred to in this particular were the present plan of the theatre, in which part of the audience is below the level of the stage and part above, and almost all at various situations and angles; and the unartistic effect of the modern proscenium arch, which is pieced out below by hangings and other movable or temporary fixtures, instead of being a true frame to the picture it encloses.

The difficulty of seating is one not to be overcome in the conditions under which the modern theatre thrives. In a house of a given size it is essential that every available spot be used by spectators, who, as the *Builder* editorially remarks in discussing this paper, would rather pay less for seeing the play in an unsatisfactory seat in a gallery than the prohibitive price that would be required were the seats limited to a single floor level, rising in a slight curve or incline from the stage. Prof. Herkomer does not appear to be familiar with the form of theatre devised by Messrs. Adler and Sullivan of Chicago, and so finely illustrated in their Auditorium and Schiller Theatre in that city. It is true that the difficulty referred to by the professor is not overcome in these American theatres, but they afford certain conveniences of plan and novelty of arrangement with which every writer on the theatre, and especially on its artistic aspects, should be familiar.

As to the relation of the proscenium to the picture on the stage, it is obvious that we cannot have every stage-picture of the same size, though it is clearly absurd, as the professor points out, to represent a room in a cottage as of the same size as a hall in a palace. But the proscenium is more than a frame to the stage picture; it is an integral part of the architecture of the interior, and much of the success of the architect's design depends on the nature of his stage-opening. It is true enough that the purpose of the proscenium is to provide an opening for the picture on the stage, but its relation to the scheme of architectural decoration cannot be ignored. The reader interested in scenic art will do well to read the whole of the professor's article for fuller particulars as to his experiment.

The Beaux Arts Society of Architects?

THE AMERICAN ARCHITECT (December

14) contains the pleasing announcement that at the annual meeting of this organization in December a form of initiation for the admission of new members was adopted. We congratulate the society on this advance, and beg to assure it of our warmest interest in this occurrence. Those of our readers who will take the trouble to refer to their copies of this magazine for June, 1894 (Vol. VII, p. 418), will find that we long since pointed this out as an omission in the programme of the society, and it is with no usual pleasure that we find our suggestion acted upon. Our informant adds that the ceremony added much to the "fun" of the occasion. We do not understand why this should be so. On their own account, and taken at their own valuation, the members of this organization are the only Consecrated and Earnest architects now doing business in America. Why, then, should admission to this solemn Order be an occasion of "fun"? That it should be a joy for the neophyte to become one of the Fold can readily be seen; that it should be a source of happiness is true enough; that it should be an occasion for general congratulation may be true also. But "fun"? Surely this is scarcely the word with which to describe so solemn a ceremony!

Our readers will recall that we ventured to make two suggestions, at different times, to the members of the Beaux Arts Society. One of these has now been acted on; we trust that our other suggestion—the making of the editor of the *Architectural Review* an honorary member—will not be further postponed.

High Buildings and Fires.

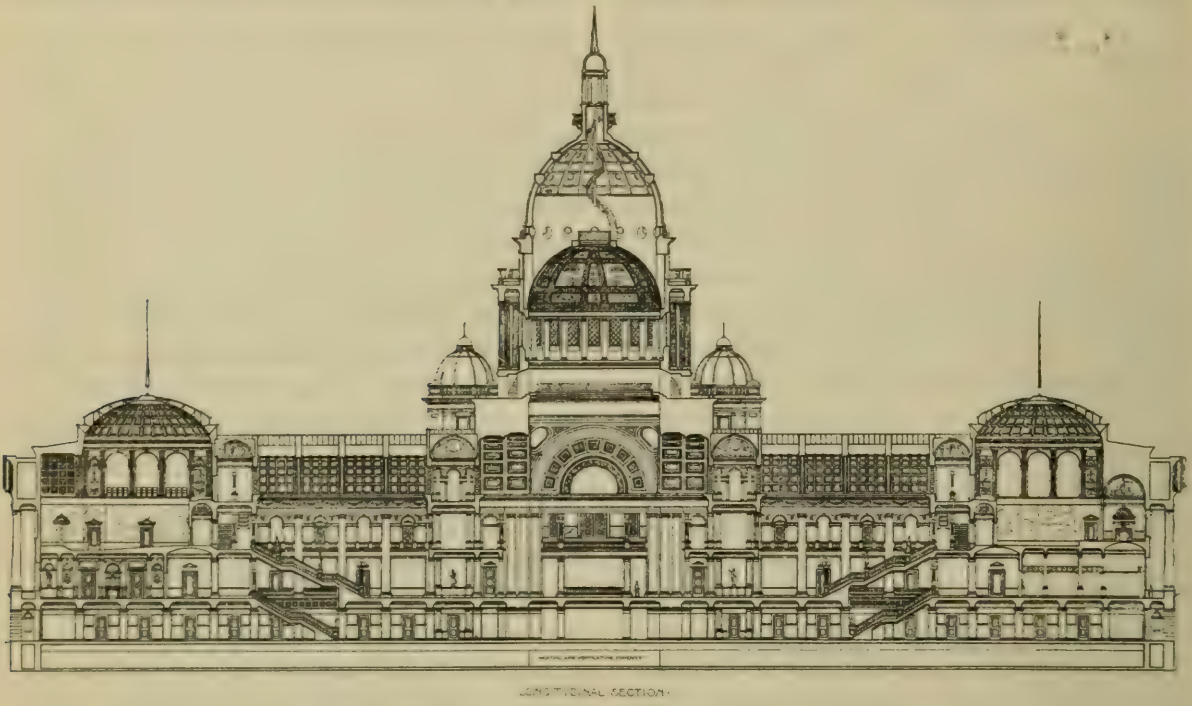
GEN. WM. SOOYSMITH contributes a paper to *Stone* for December on the dangerous character of the modern steel fireproof office-buildings. The writer does not believe in the safety of this method of construction, and argues that stone columns should be substituted for the present steel framework, which he regards as radically unsafe. He claims also that the terra cotta fireproofing is quite inadequate to resist the destructive force of a severe fire.

It is a matter to be regretted that so distinguished an engineer, who has taken much active part in the erection of a number of steel buildings, though his work has been largely that of making their foundations, should have seen fit to raise his voice in protest against the most carefully built structures of modern times. It is true, as he remarks, that there have been fires in buildings called fireproof, the latest notable instance being the Manhattan Savings Bank in New York, which recently experienced almost total destruction from a fire communicated to it from an adjoining structure. The burning of this building was the signal for every opponent of the large commercial building to cry aloud with horror: "I told you so."

That the bank building in question did burn down, that the fire was a bad one, and that the building was nominally fireproof are facts not to be disputed; but it is further true that no one would have offered this structure as a type of the best and latest fireproof construction. It was not a new building, and the destructiveness of the fire was largely due to defective construction.

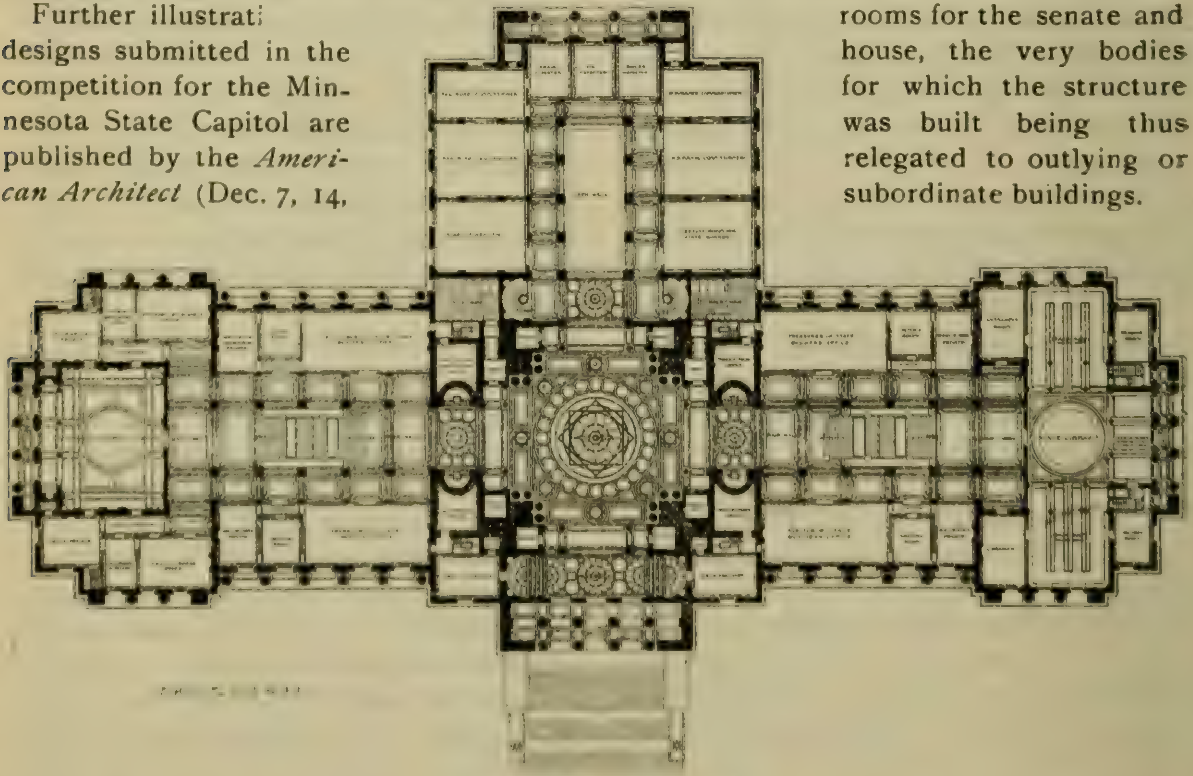
Illustrations of the Month.

THE competition of the month—these architectural scrambles for work are now so numerous that scarcely a month passes that does not witness the conclusion of one or more of them — was that of the library for the State Historical Society at Madison, Wis., of which the *Inland Architect* for December publishes three designs, commented on below. In mercantile drawings the same journal publishes a part of the fine Equitable Building in Denver, with small photographs of the interiors,—none of them new, but pleasant and agreeable reminders of one of the most notable office-buildings in the country. *Architecture and Building* (Dec. 14) publishes a fine photograph of the Constable Building, New York,—a stately and imposing structure that may rightly be classed among the most successful great buildings of the metropolis. An indistinct reproduction of a water-color drawing in *The Builder* (Nov. 30), of Moorgate Court, London, illustrates the new premises of the Ocean Accident and Guarantee Corporation,—a picturesque structure whose conception is quite as distinct from the idea of an American commercial building as its design.



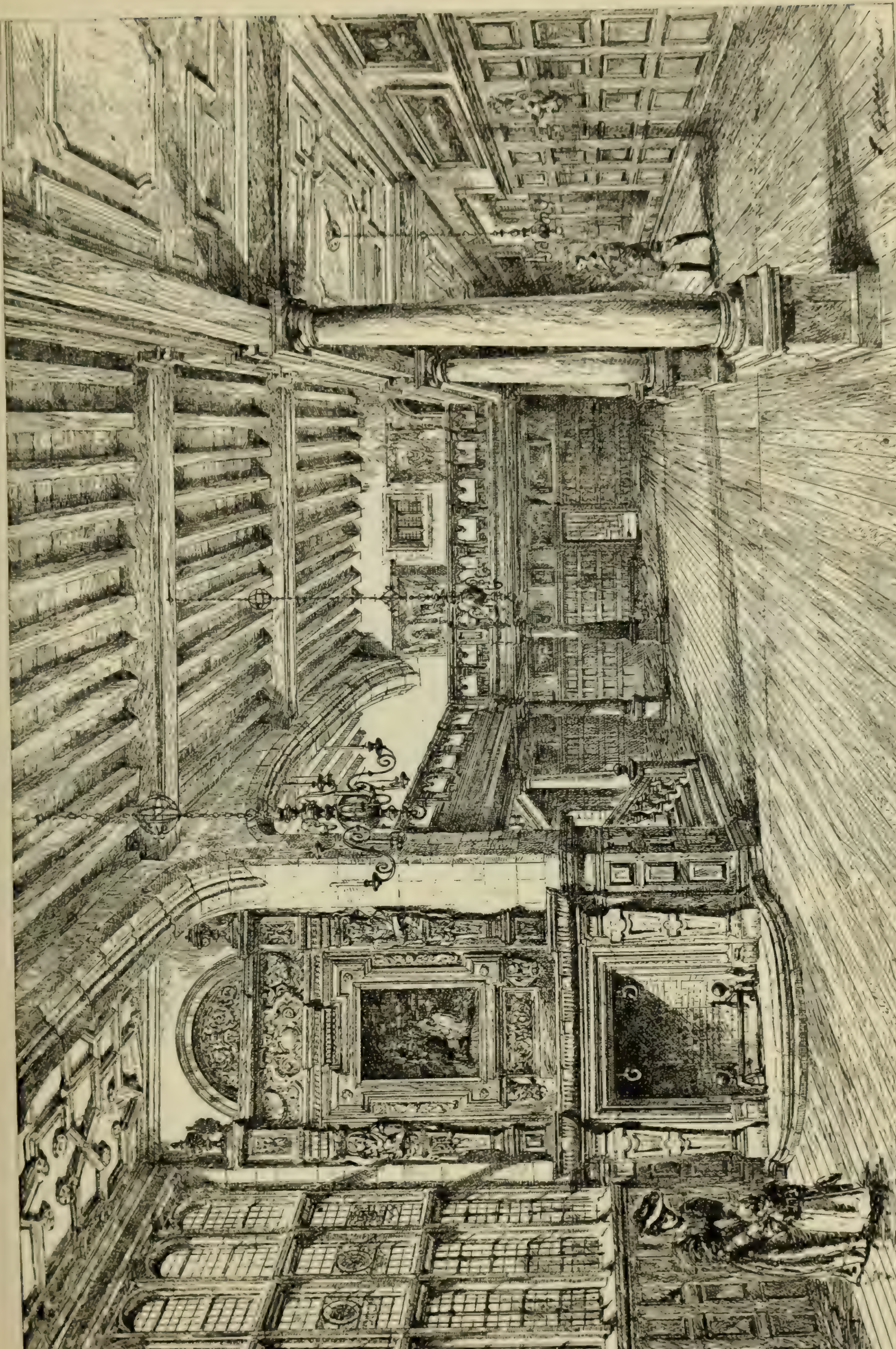
SECOND PRIZE DESIGN FOR MINNESOTA STATE HOUSE.

Further illustrati designs submitted in the competition for the Minnesota State Capitol are published by the *American Architect* (Dec. 7, 14, and 28). Of these that by Mr. E. Flagg is a grandiose composition with a striking exterior and a badly-conceived plan. It consists of a vast rectangle with an open court in the center, containing a circular base for a dome connected with the surrounding structure by stair-wells. Short narrow passages connect the central block with two outlying portions containing the rooms for the senate and house, the very bodies for which the structure was built being thus relegated to outlying or subordinate buildings.



MINNESOTA STATE HOUSE.

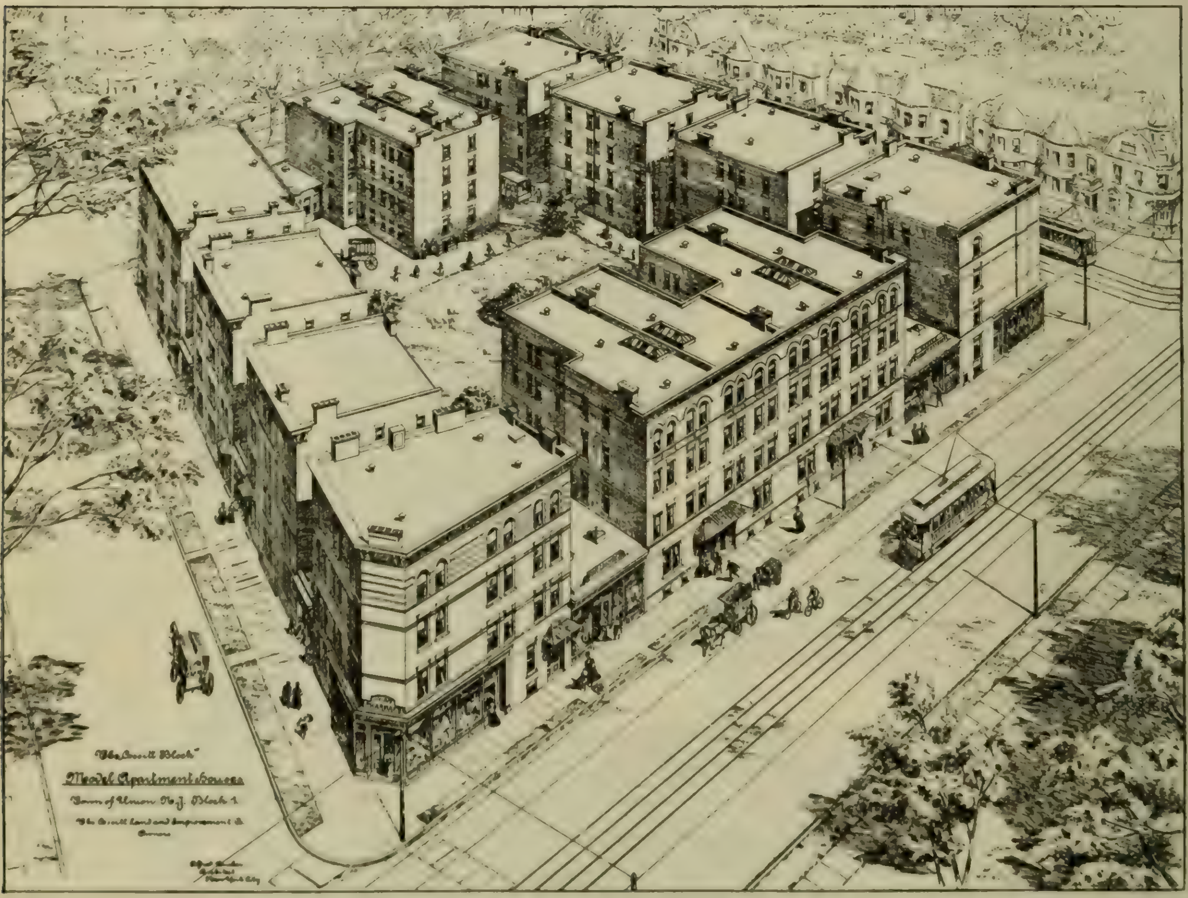
Architecture and Building (Dec. 28) prints two photographs of houses built at Madison, N. J., by Boring & Tilton. The same paper publishes a large photograph of the



ASHORNE HILL HOUSE: INTERIOR OF HALL.

house for Mr. J. J. Astor in New York by the late R. M. Hunt (Dec. 7). It is accompanied with a critical estimate of Hunt's art by Mr. Barr Ferree. An illustration of the fine Roman Catholic Church of St. Augustine in Brooklyn, by Parfitt Brothers, in the same publication (Dec. 14), should be mentioned as the most notable church of the month.

In the country houses *The Builder* (Dec. 7) publishes three pretty cottages by Mr. T. W. Cutler, together with some interesting interiors, and two groups of stables. A peculiarity of that city is the making of "places" or terraces, shut off from the more public parts of the town by gates and other enclosures. The result is a semi-secluded park, whose houses on either side have a certain ornamental and suburban air which they could not have in unenclosed streets. The illustrations referred to show how ornamental such a system of city-planning may be as well as how charming are some of the designs made for the enclosing gateways by several of the architects of St. Louis.



MODEL APARTMENT HOUSES.

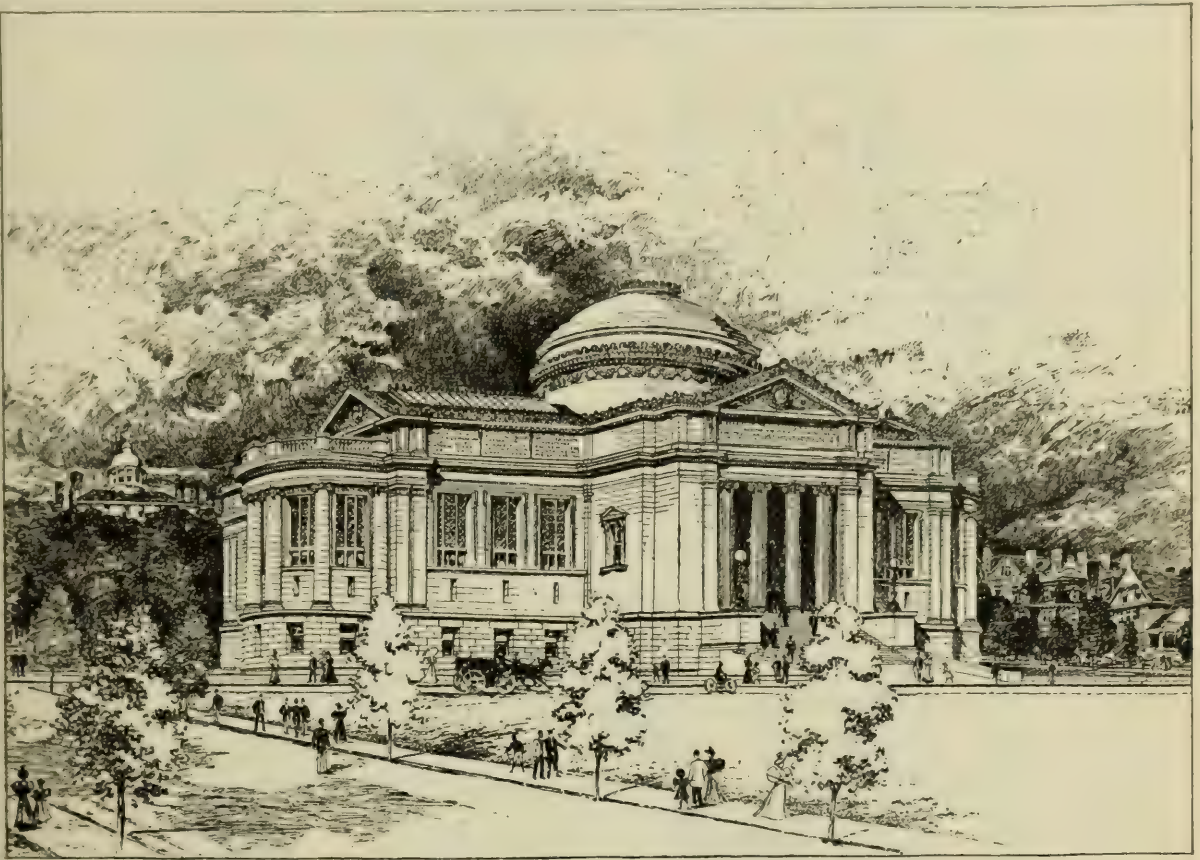
In city houses also might be included the block of apartment houses in Union, N. J. (*Architecture and Building*, Dec. 21), reproduced herewith, though there would appear no reason for tenement or apartment houses in any town of New Jersey. A group of sketches of cloisters in southern France and Italy by Mr. J. C. Halden is given in the *American Architect* (Dec. 14).

An exceedingly interesting group of municipal adornments in St. Louis is shown in photographs of four gateways, in the *American Architect* (Dec. 7 and 21).

The *British Architect* (Dec. 13) offers as a holiday supplement a series of eighteen pen-and-ink sketches by the well-known English pen-draughtsman, Mr. T. Raffles Davison. Under the general head of "A West Country Ramble," this accomplished artist presents a series of beautiful views of English churches and old houses, with several new country mansions to give it, as it were, a modern flavor. We have sketches in Malvern, Cheltenham, Hereford, Hanley Castle Church, Malvern Priory Church, Worcester Cathedral, and

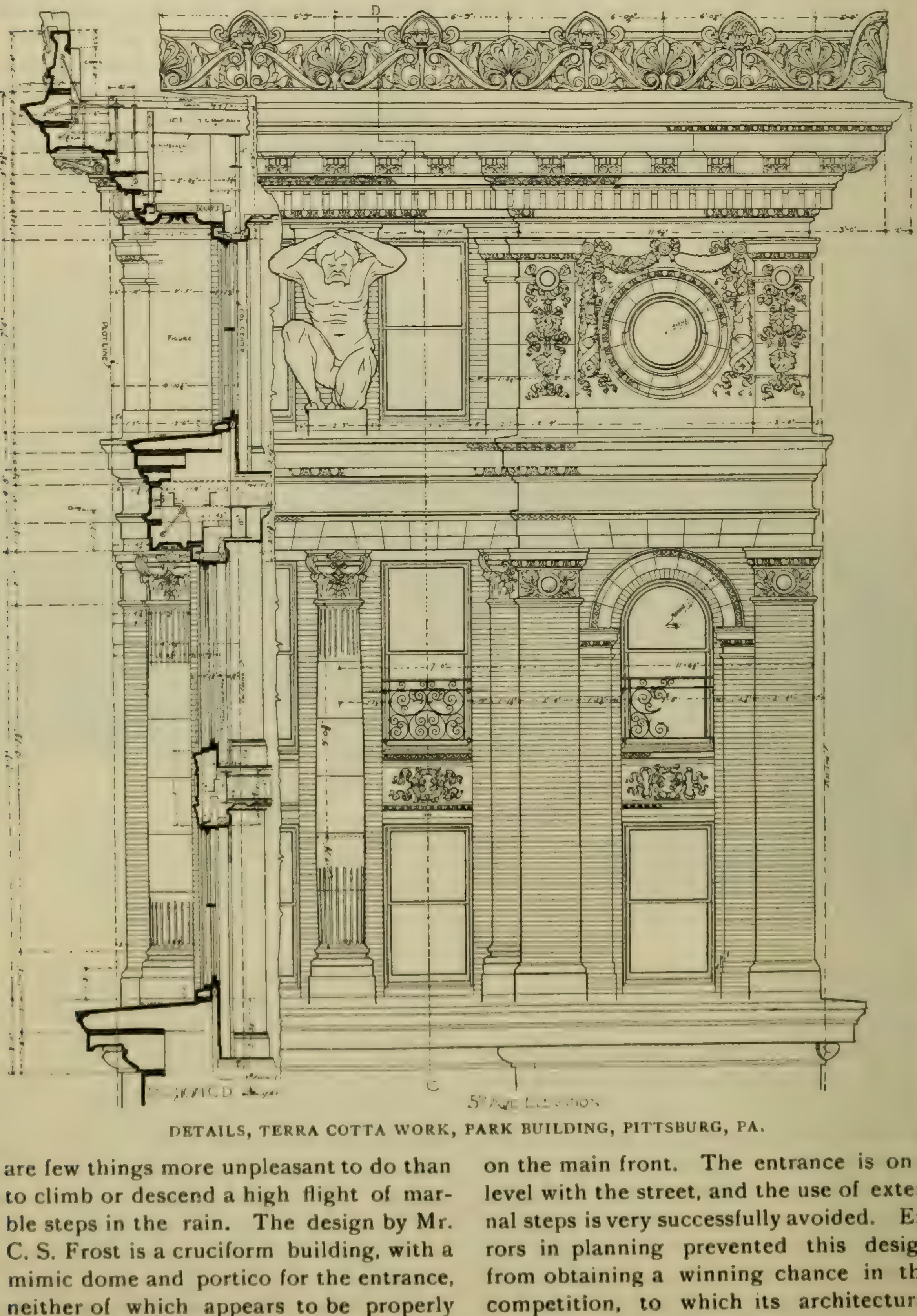
Tewkesbury Abbey; of older houses we have a view of Savern End, "Bad Batsford," by Ernest George & Pete; "Perry Croft," by C. T. A. Vosey; and "Englewood, Stroud," by P. Morley, with a couple of old houses and a sheet of carved detail. The drawings are admirably done, and will be cordially welcomed by Mr. Davison's admirers.

THE INLAND ARCHITECT (Dec.) does good service in publishing three of the premiated designs submitted in the competition for the Wisconsin Historical Society's library, the selection, which rested between two unpublished drawings, not having been made at the date of publication of that periodical. It also prints in full Professor Ware's report as expert. It is a carefully drawn document, and shows great justice of judgment, with that clear perception that has long since made its author famous. Of the ten designs submitted four were provided with the low domes that came into favor with the Fine Arts Palace and the Agricultural Hall at the Chicago World's Fair, to which buildings they bore a more or less marked resemblance. This is, we believe, the first instance where so large a portion of the designs illustrated this style of building. It is to be hoped that the fashion set in it will not become popular. The design of Messrs. Peabody and Stearns, illustrated herewith, is a long rectangle with a vestibuled pavilion in the centre and two stack-rooms extending behind. It is doubtless intended as a Greek building, though the dome that surmounts the central hall is Greek only in name. It is a monumental design,—the most so of those published,—but suffers from this very character. Why, in this epoch of elevators, should the visitors to the library be forced to climb an external flight of steps a full story in height? It is true, there are elevators within, entered from unimportant doors in the basement; but surely, if they were needed, it would have been more logical to have placed them close to the main en-



LIBRARY BUILDING, HIST. SOC., MADISON, WIS.

trance. And why a high external flight of steps? This architectural device originated in the sunny south, under clear skies and in dry lands. Is it possible that it never rains in Madison? Certainly there are few things more unpleasant to do than to climb or descend a high flight of marble steps in the rain. The design by Mr. C. S. Frost is a cruciform building, with a mimic dome and portico for the entrance, neither of which appears to be properly related to the rather severe design of the rest of the building. The design submitted by H. C. Koch & Co. is a large rectangular structure, treated in a stately manner, with slightly projecting pavilions on the corners and a connecting colonnade on the main front. The entrance is on a level with the street, and the use of external steps is very successfully avoided. Errors in planning prevented this design from obtaining a winning chance in the competition, to which its architectural form entitled it.



DETAILS, TERRA COTTA WORK, PARK BUILDING, PITTSBURG, PA.

THE BRICKBUILDER (Dec.) publishes among its admirably-chosen illustrations of recent brick and terra-cotta buildings a couple of sheets of detail of the terra-cotta work on the new Park Building in Pittsburg, Pa., by Mr. G. B. Post. The parts illustrated show the three upper stories and three intermediate ones, but, as no information is given as to the total height of the building, it would appear difficult to estimate the resultant value of this detail in the actual structure. The upper section shows a two-story feature, with columns and pilasters, with an attic story above, in which are atlantes supporting the main cornice. The design is worked out with a good deal of care. The cornice below the attic story is plainly treated, and projects but slightly beyond the wall line. It has not, therefore, the effect of deliberately cutting off the attic, which is so frequently the case in designs of this nature. Unfortunately, however, the cornice below the pilastered section has a much greater projection, though it is not so deep, and what is gained in one place is lost in the other. The atlantes *motif* was employed by this architect in his well-known Havemeyer Building in New York, though not with the best effect. There they are standing figures, and above their cornice are two additional stories, which have a most unhappy added-on effect. In the Pittsburg building the atlantes are stooping figures, the attic story being a low one, and the cornice above them is surmounted by a crest, without other stories. Judging from the published drawings, the design is a considerable advance on the New York design, though it may be questioned if a good deal of the elaborate detailing is not lost at the height at which it is placed. This is a very common failing of many of our high buildings, and is quite natural in a work that, like their design, is confined to study on paper. It is obviously impossible to effect a remedy after the building has actually been erected, but so many instances of errors of judgment are now on public view that it is strange the architects are not more alive to this circumstance. The Park Building, however, does not appear to be worse off in this respect than many others. As a matter of fact, also the Havemeyer Building is nearly free from this error.

Index to Illustrations.

APARTMENT HOUSES.—Bedford Court Mansions, London, by A. F. Vigers, Builder, Dec. 7.—Proposed Mansions, Storey's Gate, London, by B. A. Slade, ibid, Dec. 21 —"Model" Apartment Houses (with plans), Union. N. J., by A. Zucker, Archt. and Build., Dec. 21.

CHURCHES.—St. Augustine's (R. C.), Brooklyn, N. Y., by Parfitt Bros., Archt. and Build., Dec. 14.—Village Church, by J. W. Northrop, ibid.—S. Columba, Maryland Point, E., London, by E. P. Warren, Archt., Dec. 20.

COMMERCIAL.—Staircase (internal), Whitehall Court, Victoria Embankment, London, by Archer & Green, Archt., Nov. 29.—Board Room, P. & O. S. N. Co., London, by T. E. Collcutt, ibid., Dec. 6.—Interior Bank, Bolton, by Bradshaw & Gass, ibid.—Yorkshire Penny Bank, Bradford (interior), by G. J. Ledingham, ibid., Dec. 13.—Equitable Insurance Office (interior), Manchester, by Waddington & Son, ibid., Dec. 20.—Ocean Accident and Guarantee Corporation, Lt., London, by H. H. Gordon, Builder, Nov. 30.—Constable Building, New York, by W. Schickel & Co., Archt. and Build., Dec. 14.—Detail of Mercantile Building, College Place, New York, by Stephenson & Greene, ibid., Dec. 28.—Downing ing Building, Front St., New York, by H. J. Hardenbergh, ibid.—Director's Room, Paterson, N. J., Savings Institution, by E. Edwards, ibid.—Union Trust Building (detail), St. Louis, by Adler, Sullivan & Ramsay, Amer. Archt., Dec. 7.—No. 18 Great Marlborough St., London, by P. Stone, ibid., Dec. 14.—Bank, Bolton, England, by Bradshaw & Gass, ibid., Dec. 21.—Equitable Building, Denver (with interior photos), by Andrews, Jaques & Rantoul, Inland Archt., Dec.—Premises at Vancouver, B. C., by R. M. Fripp, Canadian Archt., Dec.—Factory Building, Toronto, by H. Simpson, ibid.—Details of Park Building, Pittsburg, Pa., by G. B. Post, Brickbuilder, Dec.—New Bank, Morecambe, England, Brit. Archt., Dec. 20.

GATEWAYS.—Washington Terrace, St. Louis, Mo., by G. R. Mann, Amer. Archt., Dec. 7.—West Entrance, Westmoreland Place, St. Louis, by T. C. Link, ibid., Dec. 21.—East Entrance to same by Eames & Young, ibid.—West Entrance, Vandeventer Place, St. Louis, by Stewart, McClure & Mullgardt, ibid.—East Entrance, Portland Place, St. Louis, by T. C. Link, ibid., Dec. 28.

HISTORICAL.—Great House, Grand Andelys, Archt., Nov. 29.—Castle at Dieppe, ibid., Dec. 20.—St. Jacques, Dieppe, ibid., Dec. 6, 13.—Chantry of Abbot Ramrige, St. Alban's Cathedral (elevation, sections) Builder, Nov. 30.—Sketches, Reims Cathedral and St. Etienne le Vieux, Caen, ibid., Dec. 7.—Marble Screen and Throne in S. Lorenzo, Rome, ibid., Dec. 21.—Newgate Prison, London (elevation and details), ibid.—

Cloisters at Fontfroide, Arles, Mont St. Michel, St. Martino at Naples, Verona, Amer. Archt., Dec. 21.—Court of Hotel Cujas, Bourges, France, ibid., Dec. 28.—Window in tower, Chiaravalle, Brickbuilder, Dec.—Door, Hotel Garizot, Paris, Inland Archt., Dec.—Glasgow Cathedral Rood Screen, Brit. Archt., Dec. 6.—St. Mary's, Ingatestone, Essex, Brit. Archt., Dec. 20.—The Five Orders by Vignola & E. G. Lind., Southern Archt., Dec.

HOSPITALS AND HOMES.—Proposed Children's Home, Montclair, N. J., by F. E. Wallis, Archt. and Build., Dec. 14.—Webb Academy and Home for Shipbuilders, Fordham Heights, New York, by A. B. Jennings, ibid., Dec. 21.

HOTEL.—At St. Joseph, Mo., by E. J. Eckel, Inland Archt., Dec.

HOUSES, CITY.—For late W. Burgess, Kensington, London, by himself, Amer. Archt., Dec. 7.—For W. McMillan and W. H. Thornburgh, Portland Place, St. Louis, Mo., by Eames & Young, ibid.—For J. J. Astor, by New York, by R. M. Hunt, Archt. and Build., Dec. 7.—For Dr. F. Gurd, Montreal, by R. Findlay, Canadian Archt., Dec.—For Mrs. Holmes, Pittsburg, Pa., by Peabody & Stearns (with plan), Brickbuilder, Dec.—In London, England, by W. H. Raffles, Brit. Archt., Dec. 20.

HOUSES, COUNTRY.—Interior Hall, by B. Scott and S. Morris, Builder, Nov. 30.—Small houses (3), by T. W. Cutler, ibid., Dec. 7.—Proposed Cottages, Harrow, by T. P. Figgis, ibid., Dec. 14.—House near Leicester, by J. Ransome, ibid.—Ashorne Hill House, interior of hall, by E. Goldie, ibid.—For J. Joicey, Poulton, Gloucestershire, by C. J. Blomfield, ibid., Dec. 21.—"Philiphaugh," Selkirk, by W. Wallace, ibid., Dec. 28.—At Lowestrom, by A. C. Blomfield, ibid.—House on Bay Shore, Mass., by A. W. Cable, Archt. and Build., Dec. 7.—Houses at Madison, N. Y. (2), by Boring & Tilton, ibid., Dec. 28.—Villa (elevations, plans) by H. Valette, Amer. Archt., Dec. 14.—For J. C. Hoagland, Seabright, N. J., by Shepley, Rutan & Coolidge (3), ibid., Dec. 28. Bedston Court, Birkenhead, England, by Grayson & Ould, ibid. —Near Coleshill, England, by E. C. Bewley, ibid.—For Prof. Bradley, Evanston, Ill., Inland Archt., Dec.—"Artist's Summer House," by E. E. Deane, ibid.

LIBRARIES.—Virginia Library, McCormick Theological Seminary, Chicago, by Shepley, Rutan & Coolidge, Amer. Archt., Dec. 14.—Design for West Ham Institute and Public Library, by Essex, Nicol & Goodman, Archt., Dec. 13.—Design for same, by Lauchester, Rickardo & Morris, Brit. Archt., Dec. 27.—Competition Design for Hampstead General Public Library, by Horace Field, Builder, Dec. 28.—Premiated Designs for Library Building, State Historical Society, Madison, Wis., by Peabody & Stearns, H. C. Koch & Co., C. S. Frost, Inland Archt., Dec.

MINNESOTA STATE CAPITOL.—Second Prize Design, by G. R. Mann, Amer. Archt., Dec. 7. —Design by E. Flagg, ibid., Dec. 14.—Design by Wyatt & Nolting, ibid., Dec. 28 (each with plans, views, elevations, sections).

MISCELLANEOUS.—A West Country Ramble, 18 pen and ink sketches (churches and houses), by T. Raffles Davison, Brit. Archt., Dec. 13.—Electric Light Engine House, Wickham Hall, Kent, by W. Millard, Builder, Dec. 28.

MONUMENTS.—Mausoleum for G. P. Morosini, Woodlawn Cemetery, New York, by Jardine, Kent & Jardine, Archt. and Build., Dec. 7.—Tombs at Hirschberg, Silesia, Amer. Archt., Dec. 21.

PUBLIC BUILDINGS.—Central Hall and Pump Room, New Baths, Harrogate, England, by Baggallay & Bristowe, Builder, Nov. 30.—City Assembly Rooms, Birmingham, England, by Draysey Bros., Amer. Archt., Dec. 14.—Houses of Parliament, Berlin, Germany, detail of Council Chamber, ibid., Dec. 28.—Imperial Law Courts, Leipsic, Germany (with two interiors), ibid.—Redcliffe Parish Room, Bristol, England, by H. O. M. Hirst, ibid.

SCHOOL.—High School, Marlborough, Mass., by Wheelwright & Haven, Brickbuilder, Dec.

STABLES.—Graythwaite Hall, Windermere, England, by R. K. Freeman, Builder, Dec. 7.—Shaw Hill, Wiltshire, England, by E. J. May, ibid., Dec. 14.

STUDENT'S WORK.—Study for Conservatory of Music, by L. F. Pitcher, Archt. and Build., Dec. 21.

TOWN HALL.—Carleton Place, Ontario, by G. W. King, Canadian Archt., Dec.

THE ENGINEERING INDEX—1896.

Current Illustrations and Leading Articles on Architecture and Building in the American and English Architectural and Engineering Journals—See Introductory.

*3007. Architectural Sculpture in America. Ill. Russell Sturgis (A critical review of the purely decorative sculpture employed by leading American architects). Eng Mag-Feb. 2800 w.

*3077. Architectural Education. Dr. Rowand Anderson, and Editorial (Extract from presidential address to the members of the Edinburgh Architectural Assn.). Builder-Dec. 7. 5000 w.

*3078. The Planning of Board Schools. Charles Henry Wyatt (A paper read before the Manchester Soc. of Arch. Views based on practical acquaintance with school life). Arch, Lond-Dec. 6. 4500 w.

3081. Commissioner Russell's Report on the New York State Capitol (An abstract of the report which was adopted, and plans ordered prepared in accordance with the recommendations). Arch & Build-Dec. 14. 1300 w.

*3156. The Fire-Trap Modern "Sky-

Scraper." William Sooy Smith (A thorough discussion of the inadequacy of so-called fire-proofing, as applied to modern tall buildings, and a proposed plan for rendering them really fire-proof. Gives an account of tests of the crushing strength of stone columns of a stated construction, and believes they may be practically and advantageously substituted for steel in tall structures). Stone-Dec. 3400 w.

3160. The Advantages Claimed for Brick and Steel Factory Buildings (Describes the style of construction called "composite," and states its advantages. Examples, recently erected in Providence, R. I., by the Berlin Iron Bridge Company, meet with great favor). Ir Age-Dec. 19. 1500 w.

*3173. The New Building of the Boston Public Library. T. R. Sullivan (A very interesting and finely illustrated description). Scribner's Mag-Jan. 3800 w.

†3188. The Study of Architectural History at Columbia College. William R. Ware (The writer claims that exceptional advantages are given. Beside instruction by text books and lectures, separate exercises are given in Historical Research, Historical Drawing, and Historical Designing(. Sch of Mines Quar-Nov. 4400 w.

*3212. Iron and Steel for Building Structures (The use of iron and steel in building is exemplified by brief and general illustrated descriptions of numerous tall buildings in American cities). Ir & Coal Tr Rev-Dec. 13. 2300 w.

*3213. Scenic Art. Prof. Herkomer (An address before the Arch. Assn., London, considering the construction of the auditorium of theatres ; realism on the stage ; and the lighting of the stage). Arch, Lond-Dec. 13. 9000 w.

*3214. Mural Painting by the Aid of Soluble Silicates and Metallic Oxides (A paper by Mrs. Lea Merritt and Prof. Roberts-Austen, read before the Soc. of Arts. Results of experiments by the writers, in the hope of promoting the advance of decorative art in relation to the church). Arch, Lond-Dec. 13. Serial. 1st part. 5200 w.

3219. The Montclair, N. J., Bank Building. Ill. (Plans and details of a banking and office building). Eng Rec-Dec. 21. 1500 w.

3225. A Churchyard of Palaces. Ill. L. von Krockow (An interesting description of architectural features of some towns in North Germany). Am Arch-Dec. 21. 2300 w.

3270.—$1.50. Hollow Tile Floors, Past and Present. Fr. von Emperger (The development traced, with accounts of tests made, and suggestions of requirements according to load and span submitted by the author for discussion). Tr Am Soc Civ Eng-Dec. 3300 w.

*3304. The Origin of the Hellenic Ionic Volute. Max Ohnefalsch-Richter (Abstract of a paper read before the Roy. Inst. of Brit. Arch. Concludes that the Ionic volute was derived from the Egyptian lotus-flower design, with reasons). Arch, Lond-Dec. 20. 800 w.

*3305. An Historical Review of Architecture. Willian Ransom (A popular lecture given at the Victoria Institute). Arch, Lond-Dec. 20. Serial. 1st part. 900 w.

*3307. An Australian Opinion on Tiles and Slate. James Nangle (From a paper on "Roof Coverings," recently read before the Eng. Assn. of N. So. Wales, with table showing absorption of water by different varieties of roofing tiles and slates used in Sydney). Builder-Dec. 21. 1000 w.

3355. Iron Construction and Erection of Tremont Temple. C. H. Blackall (Detailed illustrated description). Eng Rec-Dec. 28. 3200 w.

†3401. The Sculptured Columns of the Temple of Diana at Ephesus. Ill. Alex. S. Murray (Read at a meeting of the Royal Inst. and followed by discussion. Architectural points to be determined in the reconstruction of the temple). Jour of the Roy Inst of Brit Arch-Nov. 21. 9000 w.

†3402. Some Recent Discoveries at Nemi, in the Roman Campagna. Ill. J. Tavenor Perry (An account of what has already been accomplished in the exploration of this interesting region). Jour of Roy Inst of Brit Arch-Dec. 5. 1500 w.

†3403. The Brotherhood of Architects: An Essay. Paul Waterhouse (Originally delivered as a sessional paper before the Sheffield Society of Architects and Surveyors). Jour of Roy Inst of Brit Arch-Dec. 5. 5200 w.

3412. Myths, Superstitions, Romance and Humor of Architecture and Building. Fred. T. Hodgson (An interesting account of the traditions connected with ancient buildings). Arch & Building-Jan 4. Serial. 1st part. 2000 w.

3413. Sculptured Decorations by J. Massey Rhind. Neil Macdonald (Illustrated description of sculpture decorations for buildings by the artist named—principally the work done for the American Surety Building). Arch & Build-Jan. 4. 800 w.

3414. Arch and Vault Tests of the Austrian Society of Engineers and Architects (Report of the Committee, with illustrations). Arch & Build-Jan. 4. 1400 w.

†3512. The Modern Office Building. Barr Ferree (A lecture delivered before the Franklin Inst., Nov. 15, 1895. An able summary review with references, in foot notes, to the recent literature of the subject from which more extended accounts of the points brought under discussion may be obtained ; these references not being quoted as authorities, but as forming a key to more extended study). Jour Fr Inst-Jan. Serial. 1st part. 5000 w.

3522. A Notable Church Moving Operation. Ill. (From *Carpentry and Building*. The moving of a large stone church with a high tower, all of the most massive construction, in Chicago, Ill.) Ir Age-Jan. 9. 1200 w.

3533. Tests of the Strength of a New Fire-proof Floor (Floor construction invented by G. Knoche. The advantages are cheapness and the very small space taken up by the floors, walls and partitions). Eng News-Dec. 12. 600 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

The Simplon Tunnel.

THIS tunnel will be 12¼ miles long, making it much the longest tunnel in the world. The contracts have been made and the plans prepared, and the work will be finished in about 5½ years. The tunnel will be double, having large sections for traffic and a smaller one, connected with it at intervals, for the purpose of ventilation. London *Engineering* (Dec. 6) gives an excellent account of the organization and plans, and full description, with drawings illustrating the method of construction. It says:

"There is now every prospect of a tunnel being bored through the Alps at Simplon to connect the Switzerland railway terminus and Brique with the Italian terminus at Domo d'Ossola. There have been many schemes within the past twenty-seven years, but difficulties, principally financial, between the two countries have involved delays and alterations. However, a convention between Italy and Switzerland has at last been signed, and the work will now be proceeded with.

"We have recently described the several Alpine tunnels in detail, but it may be interesting here to give one or two figures which indicate the relative importance of the several tunnels as compared with the Simplon project:

	Simplon	St. Gothard.	Mont Cenis.	Arlberg.
Length of tunnel ....miles	12.26	9.3	7.98	6.36
North or east portal above sea level. ft.	2254	3639	3766	4566
South or west portal above sea level ....ft.	2080	3757	4164	3998
Highest level.... ft.	2314	3788	4248	4300
Maximum grade in tunnel per 1000...	7	5.82	22	15
Maximum thickn'ss of mount'n above tunnel..........ft	7005	5598	5428	2362
Possible maximum temperature of rock...deg. Fahr	104	85	85	65

"The tunnel will pass through the mountains in practically a straight line S. E.-N. W.

"From the northern portal there is to be a rise of 175 ft., equal to 2 per 1,000,—a minimum for drainage to the Rhone,—and the decline to the southern portal is on a grade equal to 7 per 1,000. This is a much lower gradient than in the Mont Cenis and Arlberg tunnels, although rather more than in the St. Gothard.

The tunnel, beginning at the Swiss end, runs through three miles of gypsum and six miles of limestone, schists, and gneiss, the remaining part running through mica schist and gneiss. "The temperature between kilometers 6.6 and 17.1 will be greater than the maximum of 85 deg. at St. Gothard, and it is anticipated here that it may possibly reach 104 deg., assuming here also the increase to be 1 deg. for each 144 ft. of superincumbent earth. There will be two parallel tunnels for single lines, 55 ft. 9 in. apart.

"In driving the tunnel there will first be small headings. These headings will be about 10 ft. high and 12½ ft. wide, and, as in Fig. 11, will be lined where necessary. At intervals of 220 yards there will be cross galleries of similar section connecting the two tunnels. Of the two headings, only one will, in the meantime, be opened out to the full section, but the other will be completed when the traffic requires a double line through the mountain.

"Brandt's rotary hydraulic drilling machines will be used, although for a short distance at either end hand-drilling may be resorted to temporarily. Where gneiss has to be penetrated, the pressure will be 1,500 lbs. to the square inch; otherwise it will be 1,000 lbs. There will be six or eight machines at each heading. A feature of this drill is the form of the cutting tool. It is about 3 in. in diameter, and there are three cutting points, like claws. It is slightly rotary, and is kept up to its work by hydraulic pressure. The drill is hollowed as indicated by the dotted lines,

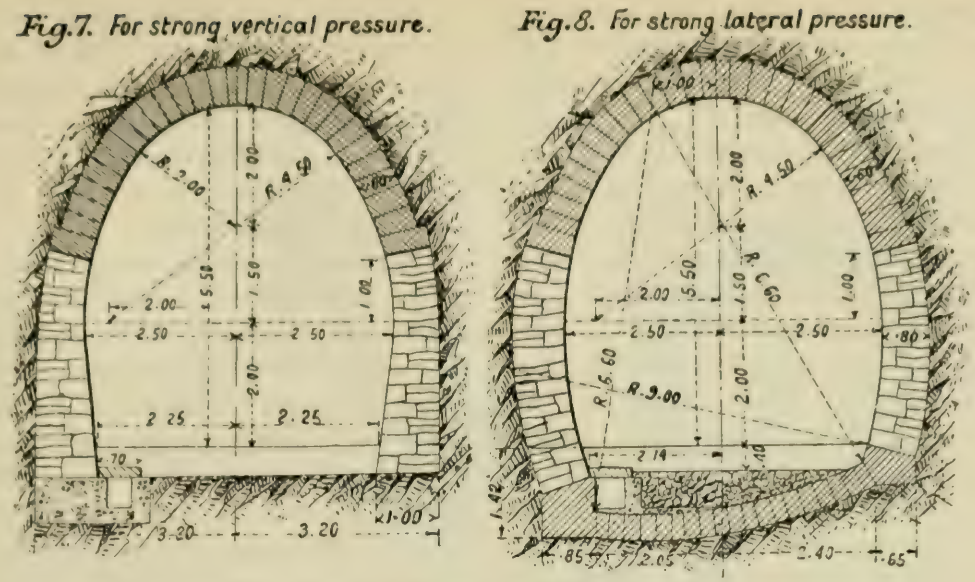


Fig. 7. For strong vertical pressure.

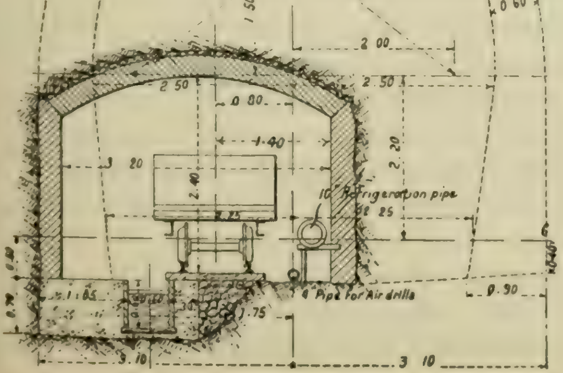
Fig. 8. For strong lateral pressure.

SECTIONS OF TUNNEL IN UNSAFE GROUND.

and through this waste water from the motors is discharged against the working face, thus keeping the cutting edge cool and at the same time washing away the *débris*. Twelve machines, it is anticipated, will require 4 gallons of water per second. In hard rock 12 to 15 holes 2¾ in. in diameter and about 49 in. deep will be needed; in schist, 8 to 10 holes 55 in. deep.

"Tests were made at Winterhur with Antigorio gneiss, the hardest rock in the Simplon, to determine the possible rate of progress. In the first experiment a hole was drilled 3 ft. 3 in. in 23 minutes, but one of the drills proved too soft. In the second experiment the time occupied in driving 4 ft. was 13½ minutes, including all delays in lengthening the borer. There was greater caution taken before the experts than would be in practice, so that the speed might have been greater.

Fig. 11. Tunnel Nº 2 in Unsound ground.



"The total contract price is, for outside work, £280,000; for first single tunnel with parallel heading, £1,900,000; for completing this heading into second tunnel, £600,000; so that the total for the two single-line tunnels complete is £2,780,000. As to the adequacy of these estimates of expenditure, the experts report at some length."

A fine of £200 for each day required over the stipulated time will be paid by the contractors, and they will receive a premium of £200 per day during such time as may intervene between completion of the work and the time set therefor.

Rules for Concrete Work.

THE following is taken from a paper in the *Journal* of the Association of Engineering Societies, having the title "Concrete Construction on the Illinois and Mississippi Canal," by Mr. J. W. Woermann, and reprinted in *The Engineering Record* (Jan. 11). These rules were compiled by Capt. W. L. Marshall.

"(*a*) All massive concrete-work should be divided into sections by vertical planes at right angles to the longest dimensions or on approximately radial lines, if curved to determine in advance the planes of weakness along which cracks due to contraction in setting or to changes in temperature shall take place.

"(*b*) These sections must be built in successive horizontal layers, as thin as practicable, each layer being well rammed in place before the previously-deposited layer shall have had time to partially set. This rule calls for continuous work, from base to coping, day and night, if necessary, and the work must be rubbed smooth on the top surface and completed without cessation of operations.

"(*c*) There must be no definite plane or surface of demarcation between the facing and the concrete backing, but the facing and the backing must be deposited in the same horizontal layers and rammed in place at the same time. As far as practicable, the matrix or mortar of the concrete should be homogeneous from face to back of wall. It is permissible to increase somewhat the proportion of cement in the mortar near the face, in order to give greater strength, but the cement must be the same as in the concrete mass. No mixture of cement and lime, or of cements of different qualities, should be made. Diverse cement concretes should be connected by dovetails.

"(*d*) No plastering or finishing of surfaces, other than sifting sand and cement on the surfaces, if too wet, and rubbing hard with a float, is allowable, or any practice that develops planes or surfaces of weakness other than the vertical planes already noted.

"(*e*) The concrete or mortar shall be mixed with no more water than they will carry without quaking in ramming; they shall be deposited immediately after mixing; and shall be kept well shaded from the sun and supplied with water, at least at the surface, until well set."

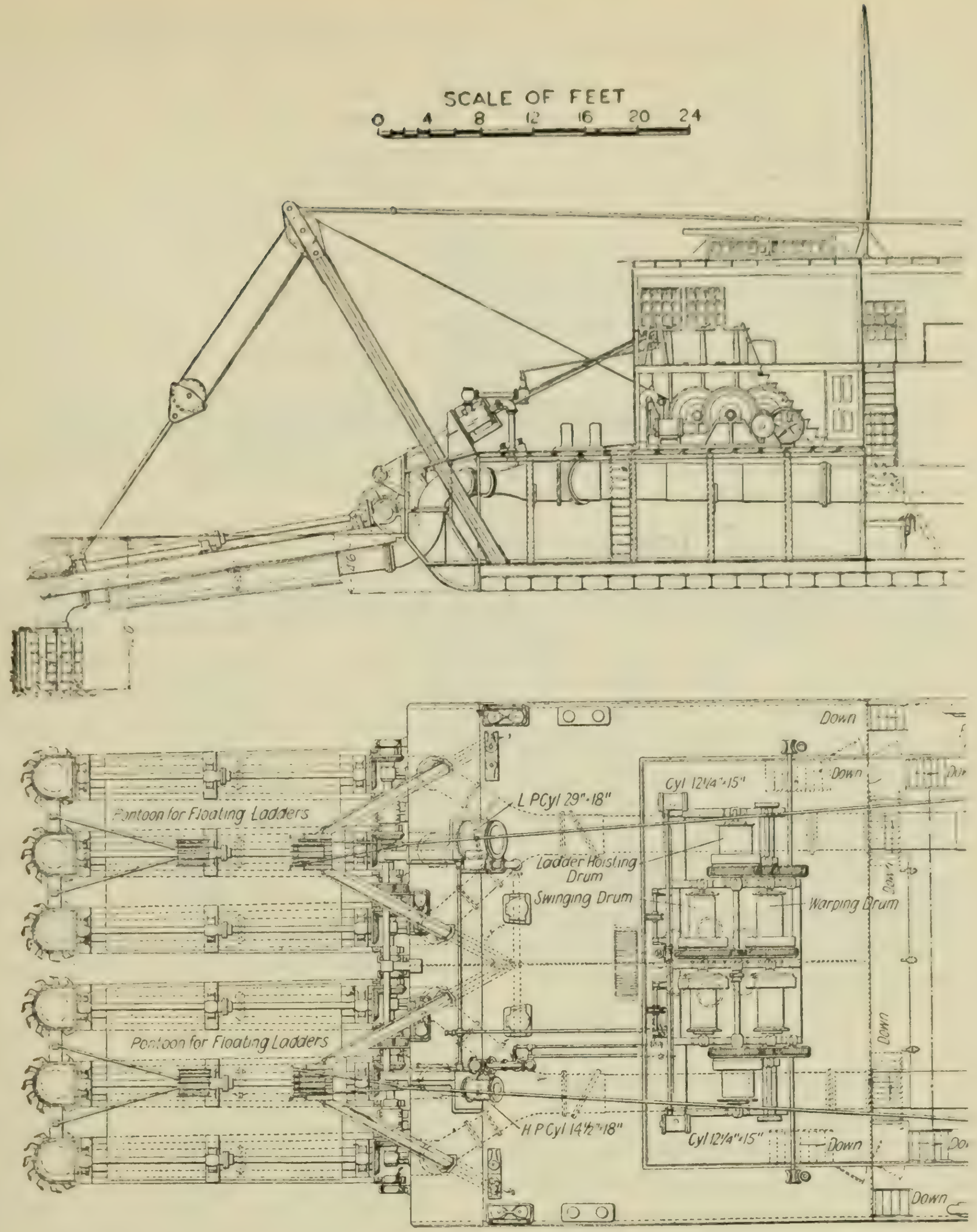
An Enormous Suction Dredge.

ANY one not acquainted with the peculiarly vacillating character of the Mississippi river channel does not appreciate the difficulties our government engineers have to contend with, not only in making a navigable channel, but also in maintaining it. As some of these dredgings involve the removal of a large quantity of sand and mud in a short time, it was found necessary to design a dredge commensurate to the task. *The Engineering Record* (Dec. 14) thus describes the first of this type now under construction:

"A great hydraulic dredge that will be larger, more powerful, and have a greater capacity for sand and mud excavation than any single machine previously built, has been designed by Lindon W. Bates, C. E., of Chicago, and is being completed on the Mississippi river at Cairo by the Maryland Steel Company, of Sparrows Point, Md., who are the general contractors with the United States government to build the dredge for working on bars and deepening and maintaining the channel of the Mississippi river. The general data of the machine are: length, breath, and depth of the steel hull, 172'×40'×7'10"; boilers, 3,000 horse power; pumping capacity, 6,000,000 gallons per hour; estimated cost, $200,000.

"In order to make a 40-foot cut through a typical bar in 24 hours, and thus provide an initial channel for the river to enlarge by its own erosion, it was assumed necessary to remove 25,000 cubic yards of material; and it was therefore specified that, to secure abundant capacity, the machine should be able to dredge at least 1,600 cubic yards per hour. It is predicted that, under favorable conditions, it will be able to dredge 3,000 cubic yards an hour, and it is expected that the official trials will develop a capacity sufficient to secure a considerable bonus offered.

"The operation of the dredge is essentially as follows: six hollow cylinders 5 feet in diameter are placed in a row 35 feet long across in front of the bow of the boat, and, when revolved about their vertical axes, cut into the bottom and loosen the soil, which, when suspended in the water, is pumped up through six 30-inch pipes, one through the center of each cutting cylinder. These pipes are connected, in sets of three, to the 33-inch suction pipes of two separate and independent and powerful centrifugal pumps that deliver the mud and water through two lines of 33 inch steel pipes with flexible joints that



U. S. SUCTION DREDGE. SECTIONS OF FORE END.

are supported on floats and convey the soil several thousand feet away, if necessary, and discharge it at the necessary height for deposition on waste dumping grounds or for filling in swamps and building up dams, levees, etc. The dredge is moved longitudinally, laterally, and radially when at work by the operation of spuds, and is equipped with a complete power plant and apparatus for auxiliary service.

"The mechanical cutter system is capable of working to adjustable depth up to 26 feet; an excavating apparatus for severing the dredged material to bring it within the field of the suction of the pipes is so arranged that the dredge may make a maximum straightaway cut 5 feet deep and 36 feet wide on the bottom in any fixed position of the cutters.

"The maximum swinging cut will measure below water level 26′×5′5″×235′, bringing within the reach of the dredge without forward movement 1,400 cubic yards. The minimum width of cut with all cutters in bank is 36 feet; with three cutters in bank, 18 feet. The dredge machinery is mounted upon a double-bottomed steel hull, built of ⅜-inch plates, provided with ballast tanks and compartments, and the double bottom provides a 2-foot space divided transversely into separate cells; beside which the bulkheads are made air-tight."

The article contains full description of all parts, including directing and propulsion rigging, pumps, engines, hull, boiler-water filter, pontoon pipe, etc. Should the operation of this dredge prove satisfactory, a dozen more may be built for similar government work.

The Report of the Nicaragua Canal Commission.

"An alleged abstract of the report of the Nicaragua Canal Commission was exclusively published by the New York 'Herald' of Nov. 25," according to the *Engineering News* (Nov. 28). "The commissioners find that new and exhaustive surveys will be necessary before sufficient data will be at hand to make any conclusive estimate and report upon final location, and they give their own conclusions and estimates with this caution. The report practically condemns the present location from Greytown to Brito; or at least suggests very many marked departures from the plan proposed and increases the cost from the canal company's estimate of $69,893,660 to a 'provisional' estimate of $133,472,893. To obtain the necessary data for the finding of a final project, the Commission says that 18 months would be required covering two dry seasons and that this investigation would cost about $250,000.

"Very elaborate tables are submitted comparing the Commission's estimates of quantities and unit prices with those of the company as corrected to 1895. A comparative recapitulation of the cost is thus given:"

	Company's estimate.	Board's estimate.
Eastern division	$31,399,844	$61,306,295
Lake and river division	5,922,782	16,234,343
Western division	20,549,091	28,186,773
Lights and buoys	373,000	500,000
Management and engineering	....	4,000,000
Hospital service	....	1,000,000
Totals	$58,244,717	$111,227,411
Contingencies 20 %	11,648,943	22,245,482
Grand totals	$69,893,660	$133,472,893

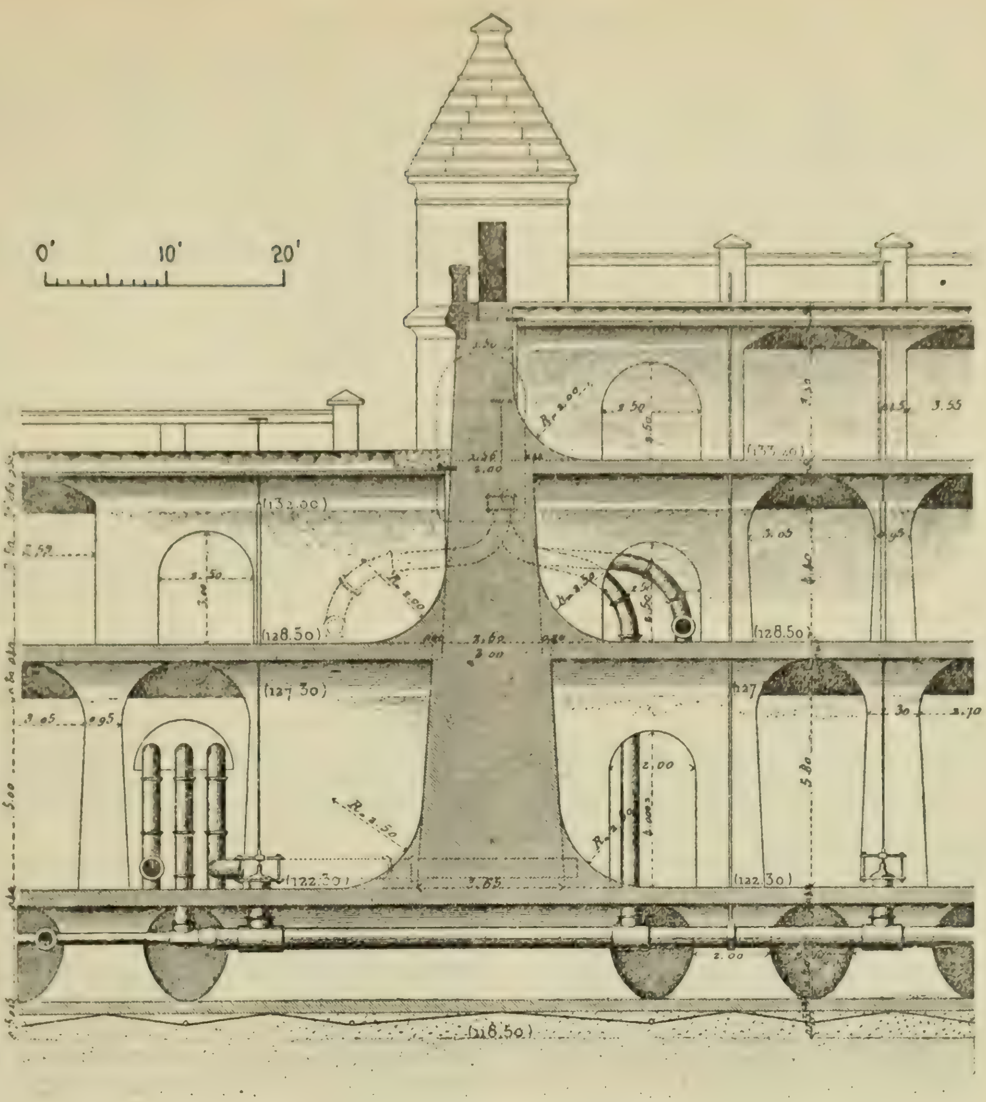
Masonry Reservoir of Montmartre, Paris.

In order to prevent leakage and possible disaster by flooding, the reservoirs of Paris have been constructed with more than ordinary care, especially with regard to devices for preventing the leakage of water into the previous underlying gypsum formation. The *Engineering News* (Dec. 26) describes the construction of the reservoirs at Villejuif and at Montmartre, Paris. The latter is of considerable interest, and we here give some extracts from the description:

"The Montmartre reservoir is located on the top of the 'Butte' at the side of the church of the Sacred Heart and covers an area of 24,800 sq. ft. Its capacity is 2,900,000 gallons. It consists of five totally independent basins, each provided with its own system of pipes and valves so that it may be emptied for inspection or repairs. The basins are in two groups, separated only by a partition wall and supported by a double bottom foundation. The first group, located at the side adjoining the church, comprises three superposed basins. The lowest has a depth of 16.4 ft. available for storage; the second has a depth of 11.5 ft.; and the topmost has a depth of 9.2 ft., or a total available depth of 37.1 ft. The second group comprises two superposed basins; the lower has a storage depth of 16.4 ft., and the upper has a depth of 11.5 ft. corresponding to the middle basin of the first group.

"The general foundation of the work was a concrete bottom 30 in. thick, resting on a bed of fine yellow sand about 16.4 ft. thick, overlying the marls above the gypsum.

"The bottom of concrete has been built in such a manner that the water permeating the masonry cannot pass entirely through it, and the surrounding earth cannot be injured by leakage from the reservoir. For this purpose, the 30 in. total thickness of the bottom has been divided into two portions. The lower part, having a thickness of 20 in., has its upper surface formed into a series of shallow channels, covered with an impervious layer of Portland cement mortar. Four-inch open joint tile drains are placed in the lowest part of



Longitudinal Section.

each channel, and lead to an accessible gallery, forming a main collector, which connects with a public sewer. Any water which may permeate the upper part of the floor is guided by the impervious coating to the drains, and thus to the sewer, and has no opportunity of reaching the sand foundations.

"The pillars serve as supports to the columns of the stories above. The latter decrease in cross section as they ascend, and are built of gritstone masonry, except the brick columns of the top basin. They rest directly on the cement covering of the corresponding floors. Supported on the brick columns are the groined arches of double course brickwork, forming the roof. These are placed around the walls by cylindrical arches, and at the angles by cloistered arches resting on buttress piers of the same thickness as the columns, and pierced with passages from 6.5 to 8.2 ft. wide. The columns and buttress walls are covered with a coat of cement mortar, like the exterior walls and floor, while the arches supporting the floors remain uncoated, so as to allow any water which may pass through the coating of a basin to pass into a lower basin or into the galleries of the double bottom.

"Cracks due to expansion or contraction occur more often in the bottom than in the exterior walls. When a crack has been located, the coating of cement mortar is picked away for 2 to 2½ ins. on each side of it, the fissure is scraped with an iron blade, and is then well washed. A slip of wood or cardboard 0.04 to 0.08 in. thick is placed in the crack, and a coating of Vassey cement 0.4 in. thick is laid on each side of it. When the slip is withdrawn, it leaves an opening of uniform width. The cement is thoroughly dried by means of small charcoal braziers, and the empty space is then filled with pure unvulcanized india rubber cemented to the coating by a solution of india rubber in benzine. Finally the opening is closed with cement mortar, and surfaced off. This last coat generally cracks, but the water that penetrates it is stopped by the india rubber, which also permits a slight expansion or contraction of the masonry. This method of repairing cracks is due to Chief Engineer Couche, who has introduced it quite generally in the Parisian water-works service."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

*3080. Rapid Bridge Building (An account of the rebuilding of the Cutter bridge which passed over the river Ouse at Ely in about eleven hours actual working time). Ill Car & Build–Dec. 6. 400 w.

*3091. New Railway Bridge Over the Weichsel at Dirschau. (Description of German bridges, built side by side, as illustrated by *Le Génie Civil*). Eng, Lond–Dec. 6. 2400 w.

*3099. Reconstruction of the Cutter Bridge, Ely ; Great Eastern Railway. Ill. (A descriptive article telling how an old cast iron bridge was replaced by a wrought iron structure without interfering with the railway traffic.) Engng–Dec. 6. 3000 w.

3175. The Cornhouse Bridge, Berne, Switzerland. Ill. Elmer L. Corthell (Description of location, method of securing plans, details of plan adopted, which is of the steel arch and pier type, and an examination into the possibility of American competition in such work). Eng News–Dec. 19. 2400 w.

*3207. The Evolution of the Iron Arch. (A short sketch of the development of the arch in construction). Eng, Lond–Dec. 13. 2400 w.

†3235. Permissible Stress in Girders. F. J. E. S. (A theoretical discussion). Ind Engng–Nov. 16. 2200 w.

3293. Compressed Air at Seventy-seven Pounds Per Square Inch (Experiments by Mr. Hersent, a French engineer, demonstrating the fact that men may work safely in caissons at a depth of 164 ft., or about 5.4 atmospheres per square inch pressure). R R Gaz–Dec. 27. 500 w.

3423. A New Steel Arch Bridge Over the Niagara Gorge. Ill. Orrin E. Dunlap (Bridge over the Niagara, replacing a suspension bridge. It will be the longest span steel arch bridge ever built). Eng News–Jan. 2. 1000 w.

*3480. Strengthening Lendal Bridge, York. Ill. (Method employed in strengthening a cast iron arch bridge to accommodate heavier traffic). Eng, Lond–Dec 27. 1300 w.

Canals, Rivers and Harbors.

*3006. The Free-Port of Copenhagen. P. Vedel (Describing the engineering work that has been done to preserve Copenhagen's position as the distributing center of the Baltic). Eng Mag–Feb. 2500 w.

3087. An Enormous Suction Dredge (A dredge designed for government work on the Mississippi river channel, having the enormous capacity of 3000 cubic yards per hour. It is thought to be the largest yet built). Eng Rec–Dec. 14. 1800 w.

*3174. Water-ways from the Ocean to the Lakes. Ill. Thomas Curtis Clarke (Interesting historical account of the Erie Canal, cost, transportation rates, etc., with comments on proposed improvements ; also brief review of the history of ship canals, with considerations relating to the Nicaragua Canal). Scribner's Mag–Jan. 4000 w.

†3184. The Missouri River. Ill. George S. Morison (One of a course of lectures delivered to the students of the School of Mines, Columbia College, under the auspices of the Department of Civil Engineering. The effects of silt-transportation as shown by map of points along the river taken at intervals). Sch of Mines Quar–Nov. 5000 w.

3233.—$1. The Advantages of the Nicaragua Route. J. W. Miller (The advantages of the route of the canal as at present located, considering the Lake of Nicaragua, its advantages to an isthmian canal, and its approaches, natural and artificial). An Am Acad–Jan. 1700 w.

3357. Paint as a Protection for Iron (Discussion at a meeting of the Engineers' Club at Phila. Practical experiences are given). Ry Rev–Dec. 28. 2400 w.

3238. Condition of Work on Chicago Drainage Canal (A graphical and tabular statement of the progress of the work, by the president of the board of trustees. The figures given are instructive and to the point). Ry Rev–Dec. 21. 800 w.

*3444. The North Sea and Baltic Canal. Max am Ende (Paper read before the Inst. of Civ. Engs. An interesting description of the work, giving many items of cost, dimensions, etc.). Ind & Ir–Dec. 27. 3000 w.

*3473. The Villa Mantle for Protecting River Banks. Ill. (The device consists of perforated clay brick, strung on zinc or other wire, and sunk on the bank to be protected. It has been used in Italy and France). Engng–Dec. 27. 300 w.

3532. Methods of Work on the Chicago Main Drainage Channel (A summary of previous articles on the canal. The purpose of the enterprise was not only to prevent the sewage laden waters of Chicago River from polluting the lake water supply, but also to be a ship canal, connecting the Great Lakes with the Mississippi River). Eng News–Dec. 12. 4500 w.

3546. The Riker's Island Cribwork. Peter Elbert Nostrand (A well illustrated description of a cribwork to prevent washing at Riker's Island, where the city refuse is dumped. The crib was built on a mud bottom, and had to be repeatedly repaired. Improved methods are suggested). Eng News–Jan. 9. 1200 w.

Hydraulics.

3088. Payson Park Reservoir, Cambridge, Mass. (Description of the construction of a billion and a half gallon storage reservoir at Hobbs' Brook, with connecting pipe lines. The construction of the central concrete core for the embankment, is an interesting feature). Eng Rec–Dec. 14. 2700 w.

†3170. Water Power of Caratunk Falls, Kennebec River, Maine. Samuel McElroy (Paper read at meeting of A. S. M. E. Describes and discusses the catchment basin, rainfall and power investment, and makes comparisons between this water power and that obtainable on other New England rivers, concluding with a discussion of site advantages, etc.) Trans Am Soc Mech Eng–Dec. 3300 w.

3269.—$1.50. Notes on High Masonry Dams. John D. Van Buren, with discussion and Correspondence (A theoretical treatment of the conditions of safety, the forces acting upon the dam, the design of a proper section, effect of ice pressure, etc., with sections of several dams and a lengthy and interesting discussion bv eminent engineers). Tr Am Soc of Civ Eng–Dec. 8000 w.

3322. Precautions in the Construction of Large Masonry Reservoirs. Ill. M. Dutoit (Translated from the "*Annales des Ponts et Chaussees*." The method and reason for the construction of double bottomed reservoirs.) Eng News–Dec. 26. 4000 w.

*3331. Stream Measurements and Water Power in Virginia and West Virginia. D. C. Humphreys (The results of work for the U. S. Geological Survey). Jour of Assn of Eng Soc–Nov. 2400 w.

Miscellany.

*3098. The Simplon Tunnel (A well illustrated description of a proposed tunnel through the Alps at Simplon, connecting Italian and Swiss railways. The contract has been let, and the principal engineering features of the work are described). Engng–Dec. 6. Serial. 1st part. 3700 w.

†3111. Railroads and Canals. Correspondence of John Stevens during 1811-1812 (Copies of some old documents, pamphlets, and letters showing the condition of canal and railway transportation at that time). Steven's Ind–July. Serial. 1st part. 6200 w.

3126. Portland Cement. Eugene A. Smith (Paper read before the Alabama Industrial and Scientific Society. Brief description of the raw materials used with analyses, and the chemical composition of a good Portland cement). Tradesman–Dec. 15. 1200 w.

3162. Portland Cement. Spencer B. Newberry (Report of the annual meeting of the Assn. of German Portland Cement Mfrs. The subjects reported on were uniform testing, specifications, the influence of magnesia, the effect of sea water, and some tests on hardening of cement). Sci Am Sup–Dec. 21. 3500 w.

3164. The Making of a Tunnel—The Waterloo and City Railway. From *The Graphic*, London (Illustrated description. The tunnel runs through clay, under the river, a total distance of a mile and a half; the excavation work is done under air pressure to keep out the river water, the iron casting following it up). Sci Am Sup–Dec. 21. 1200 w.

†3236. The "Terrameter." G. D. (Description of a rapid distance measurer, resembling a transit. Results are accurate to a foot, within 300-ft. of distance). Ind Engng–Nov. 16. 1400.

3271.—$1.50. Moving Two 36-in. Water Mains Without Shutting Off the Water. E. C. Moore, with Discussion, and Correspondence (Illustrated description with itemized cost). Tr Am Soc Civ Eng–Dec. 3300 w.

3272.—$1.50. Tests of Fire-Proof Flooring Material. George Hill (An exhaustive and valuable series of tests fully described and illustrated). Trans Am Soc Civ Eng–Dec. 6000 w.

3274. Water in Concrete. A. S. Cooper (A letter to the editor giving the results of tests tending to show that mixing mortar "wet" gives the best results ultimately though it will not do so on short time tests). Eng & Con–Dec. 20. 600 w.

3292. Plant of the Rocky Hill Stone Storage Company (A model plant in New Jersey, for the crushing of trap rock for ballast, etc. A complete description, illustrated by cut of plant, locomotive and cars is given). R R Gaz–Dec. 27. 2000 w.

*3309. The Temperly Transporter. Ill. (The transporter consists of an I beam supporting a travelling carriage. It is portable and easily adapted to any condition). Ind & Ir–Dec. 20. 1300 w.

*3332. Progress of the American Portland Cement Industry. Robert W. Leslie (Read before the Boston Society of Civil Engineers. Notes upon the general properties of cement and the later developments in manufacture in the United States). Jour of Assn of Eng Soc–Nov. 7500 w.

* 3482. The Blackwall Tunnel (The description is well illustrated, and the manner of overcoming the unusual difficulties encountered is fully treated). Eng, Lond–Dec. 27. 5000 w.

3542. The Use of a Gin-Pole for Erecting a Water Tower at Montezuma, Ia. Ill. (An economical device which is worthy of notice. This framed pole was 4 × 4 ft. in section, and afterwards carried the supply pipe from the tank, and was boarded up and packed to act as a frost box). Eng News–Jan. 9. 200 w.

DOMESTIC ENGINEERING

Domestic Water Filtering.

INDIAN ENGINEERING (Nov. 9) gives useful hints upon this subject. After some general remarks on the removal of microbes by filtering, as effected by Koch and others, and on the admitted impossibility of the complete removal of disease germs by filtering alone, at the same time conceding the sanitary value of filtration, it declares that it still regards the perfection of the system by further treatment in houses as a necessity, illustrating this point by a description of the Indian "*chatty*" filter.

"The market has been flooded many years with all sorts and manners of domestic filters. One filter that has not, up to date, found a place in the advertisements of manufacturers is the 'chatty filter' of the country. This was regarded, but a few years back, as a rough, but nevertheless valuable, adjunct to water purity. The media consisted of sand, vegetable charcoal, and pebbles. It cannot be said, that, when carefully arranged and compacted, this filter did not fulfil the function of securing a grade of chemical purity; but, in actual practice, it must have occupied a most unsatisfactory place in guarding the family circle from the inroads of disease. The management of the filter was generally delegated to the *bheestie.* It was sufficient for the house-wife to know that sand was produced, and that, say, every month fresh material was placed in the *chatties.* It was a matter of no moment whence that sand came. It is needless to say that the usual place was the bed of a neighboring *nullah*, where Ram Bux and his friends assembled in the very early morning to discuss local politics. Under such circumstances, the household energy was directed towards cleansing the sand by passing water through it, and securing a filtrate the character of which can be better imagined than described. But, since the Suez Canal was opened, most have pinned their faith on more ornamental filters designed by manufacturers of stoneware. These are usually supported by glowing statements from chemists as to the grade of purity secured. Some, not content with stating that the water was purified by bringing about a chemical change, insisted that they had overridden nature's law as to nothing going to waste by declaring that the filters required no attention whatever; they were self-cleansing! It is hardly necessary to say that the observations of any one having the slightest knowledge of hygienic conditions soon showed that all these advertisements of filters made to sell were but too often, not the saving agent, but the causes of diseases in European households. Filters, to be self-cleansing, necessarily required no care, and were delegated to the *khansmah's* intelligent supervision. Nothing was more common than to find a household trusting to a filter provided with a sponge, as the first medium through which the water was required to pass,—a gelatinous mass of inorganic filth and a breeding place for microbes. Matters such as these have, during the last two years, become of sufficient notoriety to throw doubt upon the reckless statements of manufacturers and of chemists either too greatly wedded to their own science to believe in bacteriology, or possessed of sufficiently flexible consciences to give certificates that, like the oracles of old, read in the sense the reader may feel inclined to adopt, Sims Woodhead, on behalf of the British Medical Association, carried out a very careful series of experiments, and came to the decision that, of all the various filters in the market, none but those primarily intended to act as microbe-catchers were of any real efficacy in the prevention of diseases."

Even the Berkfelde and the Chamberland-Pasteur filters (porous clay filters), which absolutely eliminate the germs when first put into use and produce a strictly sterile filtrate, will, after three days' use, no longer do so. It has been shown in the case of the Berkfelde filter that "cholera bacilli effect an entrance by *growing* through the pores of the filter." This shows the necessity of sterilizing the filter at intervals not exceeding three days, which is quickly and conveniently done by placing the porous cylinder in boiling water and keeping it there until every part of it has attained the temperature of the water and ten minutes longer. The sterilization of any filtering material can, in like manner, be effected by filtering boiling water through it for such time as will bring it to, and hold it for a short time at, the temperature of the water.

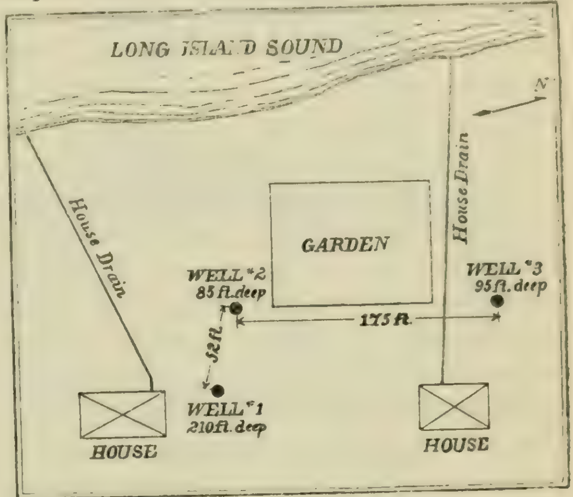
An Interesting Well Experience.

AN abstract of an article by H. De B. Parsons, in *The Stevens Indicator* (Oct.), emphasizes the caution that should be observed in locating wells for domestic water-supply.

The well in question was located near Rye, Westchester county, N. Y. An unsuccessful attempt to obtain sufficient water at the point marked 1 on the accompanying map having failed, another, at the point marked 2, succeeded in obtaining a yield of about a gallon per minute, with which, though a scanty yield, the proprietor was forced to be content. The quality of the water was then examined. The well was equipped with a small hand-pump, and water was pumped about ten minutes each day for four days, when a sample was analyzed by Mr. Alfred L. Beebe. The result of this analysis was the condemnation of the sample on account of the presence of nitrites, the high percentage of albuminoid ammonia, and nitrogen in nitrates and organic and volatile matter, indicating the infiltration of surface water of bad quality, apparently contaminated with sewage.

The well marked No. 3 had been previously bored, and had been used continuously for five years, and, as no sickness had been caused thereby, and as, from the nature of the ground, it did not seem possible that sewage contamination could be present, even from distant sources, it was decided to make an analysis from well No. 3.

The analyses of the waters of these wells showed that the water was of the same general character, and that it probably came from a common source. There was a marked difference, however, in the quantity of nitrogen present, and of free and albuminoid ammonias. The reduction in the quantity of total solids by evaporation was probably due to the longer period of use, which had thoroughly cleared the well. It, therefore, seemed that the apparent contamination of well No. 2 was entirely due to the effects of dynamite exploded in well No. 1 (which had been done in the hope of increasing its yield), and for domestic purposes it was just as good as that obtained from well No. 3. A slight improvement between the first and a second analysis of the water from well No. 2 was probably due to continued pumping, which sucked into it from well No. 1 certain quantities of nitrogen, showing in the increase of the nitrates as well as in the increased amount of free ammonia.



It will probably be many months before the apparent contamination will be exhausted, and it thus appears that, under special conditions, even rock-bored wells may have their waters contaminated by infiltration. In this case, had the water been used without the precaution of a chemical analysis, the results might have been injurious to the users.

Drying Rooms.

NO first class mansion is now erected without a provision of a room wherein laundry-drying can be effected in wet weather when out-of-door drying is impossible. That the majority of domestic drying-rooms are not constructed in accordance with scientific principles is evident from an acquaintance with their construction, and comparison of it with that of such drying-rooms as would result from the application of the principles set forth in a paper on the subject by J. L. Henry, Jr., in *Heating and Ventilation* for December, an abstract of which is herewith given.

For each increase of 27 degrees in the temperature of the air its drying capacity is doubled ; in other words, the capacity of the drying-room can be doubled by increasing the temperature of the room 27 degrees. For ordinary laundry work a temperature of about 130 degrees has been found most satisfactory. When wet clothes are first placed in the room, the temperature falls from 20 to 30 degrees, but gradually moves up again as the goods become dry. The successful construction of a drying-room depends upon plenty of heat and a bountiful supply of fresh, clean air. In no system of heating are the benefits of direct radiant heat more manifest than in the drying-room ; for this reason the heating surface is most effective when so placed that the direct rays of heat from it will strike on at least one side of the article to be dried. It is even of more importance that the air-supply should be so arranged that, in addition to coming into direct contact with the heating surface, it will also penetrate and completely surround every article to be dried. A rapidly-moving current of air—say 250 or 500 feet per minute, according to the articles to be dried—is most effective.

In drying-rooms of ordinary steam laundries, as generally constructed, either no provision or one totally inadequate is made for the entrance of fresh air; this, combined with the improper arrangement of entrance and exit openings, when any are provided, results in great waste of heat and fuel, and in a prolongation of time for drying that would not be required with a properly-constructed drying-room. Many firms manufacturing laundry machinery expose their ignorance of this subject by illustrating in their catalogues drying-rooms with an exit at the top of the room only, with no provision for a supply of fresh air. An exit at the top of the room is allowable for just one object,—that is, to establish a draught in the vent chimney. After this has got well under way, the ceiling exit should be closed, and the floor exit used. With the air entering at the floor, and with the exit at the ceiling, the air will move in a straight line from the inlet to the outlet and become only partly saturated, the result being a loss of heat and fuel. With the inlet and exit at the floor, the air is brought in contact with the articles to be dried in both the upward and the downward current; and, being confined longer, becomes more fully saturated. From the above it will be seen that the two points to be looked after in the construction of a drying room are : (1) to have sufficient surface to heat the air to a high temperature, and to have it so arranged that the radiant heat will be most effective,—that is, so that it will strike against all of the articles to be dried, if possible ; (2) to have the inlet and main exit at the floor, of ample size, and so arranged that the air will not become thoroughly heated upon entering, but will penetrate and surround the goods to be dried.

Domestic Boiler Explosions.

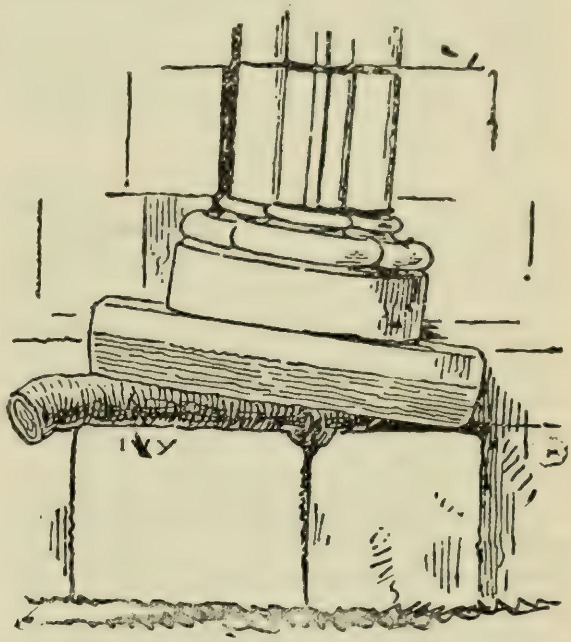
As to explosions of heating boilers, Mr. R. C. Carpenter, in *Heating and Ventilation* (Nov. 15), says that, considering the total number of heating boilers in use in the United States, the number of domestic boiler explosions is very small ; " so that, if we suppose no improvement in construction over the ordinary methods, the risk which any person would run is very slight ; and it seems quite probable that, if one were to use a heating boiler as safe as the average boiler, the chances would be that, if he did not die until killed from this cause, he would live to be ten thousand years old. And, estimating from the total number of boilers in use for heating, as compared with the number of explosions of such boilers, the chances are that one per year in ten thousand would explode."

Notwithstanding their rarity, householders should understand that explosions are possible, and that they usually result from inexcusable neglect, such as allowing water to freeze in pipes, closing valves in mains when steam is up, or faults in safety valves that proper care would discover and remove. Mr. Carpenter names several such explosions that have occurred in the United States, and expresses the view that "no boiler is entirely free from explosion when it is badly managed ; but, on the other hand, it also appears that the sectional boilers, or boilers in which the water occurs in small quantities, are subject to injuries which are comparatively slight and generally easily repaired. So far as the writer can find from a study of all the explosions recorded in the United States, the water-tube boilers, or those with small masses of water, are singularly exempt from disastrous explosion. They are, however, quite likely to have some part broken away, in which case the pressure on the boiler is relieved quickly enough to avert a serious explosion. The worst accidents which usually happen to sectional boilers are those due to the burning out of a tube or some easily replaceable part. This results ordinarily in a very severe leak, which, however, can be repaired."

Damage to Buildings by Vegetable Growths.

THE practice of training creeping plants over masonry is increasing. While a very pretty and pleasing effect can in this way be produced, there are some doubts whether the effects in inhabited buildings are not unsanitary, and there is certainty that injury to structures often results from the practice. The dampness retained by a thick vegetable growth is surely a condition favorable to the decay of timber, and —at least in a frame building—it might be one unfavorable to the health of the occupants. The possible effect upon masonry is well illustrated by a cut in *The Gardeners' Chronicle*, herewith reproduced. This represents the condition of masonry in the ancient Abbey of Cwm Hir, in Wales.

"The sketch illustrates the destructive work of ivy. An ivy stem 3 in. in diameter has bodily raised the wall pier from its setting, and at the same time pushed it forward out of the wall for 2½ in. In a second instance an ivy stem 2¼ in. in diameter has pushed through a vertical joint between two of the basal stones, and moved the wall to that extent. In so doing the ivy has split into pieces three of the horizontal stones above. Another illustration of the power of vegetation to effect the destruction of buildings is noted at Cliveden, where a branch of a fig tree growing in a forcing-house has pushed itself between the courses of the brick wall at the front of the house, and is heaving the upper courses of brick out of the level. This branch is laden with figs and well leaved out at the present time."



A Remarkable Ivy Growth.

DOMESTIC ENGINEERING says it has remained for the state board of health of Michigan, that pioneer in sanitary work, to take a distinctly forward step in the education of the people concerning the distribution of contagious and communicable diseases. The law of the state, passed last year, requires "that there shall be taught in every year in every public school in Michigan the principal modes by which each of the dangerous communicable diseases are spread and the best methods for restriction and prevention of each such disease." The state board annually sends the necessary printed forms.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Heating and Ventilation.

*3079. Ventilation and Warming. W. T. Sugg (General consideration of the subject, with special reference to the work of warming and ventilating the Houses of Parliament). Arch, Lond–Dec. 6. 4400 w.

3089. Heating and Ventilating the Adams School, Duluth, Minn. (Full description of the installment, with plans. The building having been recently enlarged, a remodelling of the heating and ventilating plant became necessary). Eng Rec–Dec. 14. 1000 w.

3189. Heating and Ventilation of the Montauk Theater (Illustrated detailed description. The ventilation apparatus is designed for cooling the building in summer, by the use of ice). Heat & Ven–Dec. 15. 1500 w.

3190. Steam Heating. Ill. (An essay copied from the catalogue of a well-known firm of heating engineers. It gives directions for estimating the heating surface required in radiators, and general instructions for piping). Heat & Ven–Dec. 15. 1400 w.

3191. Combination Systems of Heating. E. C. Moses (Gives the advantages obtainable and discusses circumstances which render the use of such combinations desirable). Heat & Ven–Dec. 15. 1200 w.

3192 Forced Blast System of Heating and Ventilation. R. C. Carpenter (A very elaborate article on an important subject, by an able writer. It discusses, and gives in tabulated form, data upon volume of air discharged at various pressures ; area in sq. inches for each 1000 cu. ft. space ; number of small pipes which provide an area equivalent to one large pipe of similar cross section ; velocity and quantity of air delivered in pipes of different diameters, each 100 ft. long, with an air-pressure equal to one half inch of water column ; capacities, revolutions per minute, and horse-power required). Heat & Ven–Dec. 15. 2400 w.

3193. Drying Rooms. Ill. J. L. Bixby, Jr. (Describes practically the essentials of drying rooms, for different purposes, and illustrates different constructions by diagrams). Heat & Ven–Dec. 15. 2200 w.

3221. An Original System of Hot Water Heating (Detailed illustrated description of a plant wherein the owner insisted that the radiation should conform essentially to the simple pipe coil system used in greenhouse work). Eng Rec–Dec. 21. 800 w.

*3265. An Entirely New System of Heating (A combination of steam and hot-water systems is described, with plans of the building in which it was installed. The advantages claimed are perfect regulation of heat and ventilation, with minimum attention. Plans of the apparatus showing details are also furnished). Dom Engng–Dec. 2500 w.

*3266. Gas Used as Fuel. O. B. Server (The policy of gas companies in cheapening the cost of production at the expense of calorific value, is criticized in this able article, as tending to retard the use of gas as fuel. Notwithstanding this, its increasing use is predicted and the subject is dealt with in a way calculated to enlighten consumers of gas for heating purposes. A new rule given for computing flow of gas through pipes, will be of interest to plumbers). Dom Engng–Dec. 1800 w.

3324. Comparative Tests of Steam-Heating Radiators (Describes and illustrates an important series of experiments upon a comparatively little investigated subject. Describes both method and apparatus and gives tabulated results). Eng News–Dec. 26. 1600 w.

3356. Ventilation of an Auburn, N. Y., School (Detailed illustrated description of an interesting plant in which indirect radiation only is employed). Eng Rec–Dec. 28. 1100 w.

Landscape Gardening.

3013. School-Grounds. (An editorial reply to a correspondent regarding the educating effects of beautifying school-grounds). Gar & For–Dec. 11. 1200 w.

3381. Village Streets and Country Roads. W. J. Beal (Suggestions tending to make the highways attractive, especially in regard to the planting of trees). Gar & For–Jan. 1. 1100 w.

Plumbing and Gas Fitting.

*3263. Proper Plumbing. Ill. George F. Hammond (An excellent article, in which an unusual amount of technical knowledge of the art of sanitary plumbing is displayed, considering that the author is an architect by profession, and not a plumber). Dom Engng–Dec. 2000 w.

*3264. American Plumbing in Bath Rooms and Kitchens. Dent Yates (Photogravure illustrations and description of typical work in high-class plumbing). Dom Engng–Dec. 450 w.

*3359. Laying House Drains. (Treating of trench, fall, joints, clearing shafts, testing, etc.). Ill Car & Build–Dec. 20. 1600 w.

Miscellany.

†3041. Domestic Filtration of Water. (A caution against so called self cleansing filters, and precautions needed in all water filtering on a small scale for domestic supply). Ind Engng–Nov. 9. 1300 w.

†3516. An Interesting Well Experience. Ill. H. de B. Parsons (The dangers of water contamination in wells sunk near residences, are well exemplified in this instructive account. The description is illustrated by a diagram showing relative positions of house, drains, wells, etc.). Stevens In–Oct. 1000 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed in the departments of Mechanical Engineering, Mining and Metallurgy, Railroading, and Domestic Engineering.

Direct vs. Alternating Currents.

ADMITTING all that is claimed for the efficiency of the alternating current as compared with that of the direct current, there yet remains the practical question of its practical adaptation to various uses.

Mr. William Baxter, in *The Electrical Engineer* (Dec. 11), began the discussion of this question, and the first part of his paper was certainly an able argument in support of the proposition that "the direct-current system would be more desirable, even if the alternating system were just as well suited to commercial requirements, which is not the case." Mr. Baxter makes the following remarks with reference to the present status of the alternating current and the multiphase motor.

"The only extensive application of the alternating current at the present time is for incandescent lighting. A few arc lights are also operated by it, but for this purpose it is far inferior to the direct current. Any one desiring to install an arc-lighting plant would not take the alternating system into consideration for a moment. Arc lamps of this type are only used where they are so far apart or so few in number as not to justify the expense of a separate circuit.

"For motor services it may be justly said that at the present time the alternating current is of no great practical value.

"The multiphase motor, when considered from a purely theoretical standpoint, should be equal in every respect to the shunt-wound constant-potential motor of the direct-current type. It will start under a heavy load, as the rotating field exerts a torque which increases as the velocity of the armature is reduced, and is at its maximum when the armature is at a standstill. The action of these motors, if considered without any reference to external objects, is the same as that of the ordinary direct-current machine. In the former the lines of force, or the magnetic polarity, rotate around the field, and the armature chases around after them until it catches up, and then they continue rotating together. In the direct-current machine the lines of force remain stationary in the field, and by the action of the commutator they tend to rotate backward in the armature, thus setting the latter in motion in the forward direction. In both cases these lines of force remain stationary in one part of the machine, and rotate through the iron in the other.

"Although, from a purely theoretical standpoint, there is nothing to prevent the rotary field motor from doing the same kind of work as the shunt-wound constant-potential motor, the fact that it has not come into use is an indication that there is some practical obstacle in the way. That this obstacle is of no small importance may be assumed from the fact that it is about eight years since the first of these machines was made, and still they are not in use, except in a few isolated cases."

The author next considers the reasons for the halt in the practical and commercial advance of the alternating current. It is admitted that theoretically it is adapted to driving constant-speed motors; but the largest field for motors is at the present time, and probably will be for many years to come, that of electric railways. For this class of work, and other work where the speed is not and cannot be constant, the alternating current cannot be used. It is pointed out that electric lighting is becoming a small interest as compared with the other branches of electrical industry, of which the supply of motors is the chief. In this view it is regarded as "folly to discard the direct current . . . . without an attempt to develop its possibilities, and to push forward a system that we know is not suited to our wants and cannot be utilized at all except with the assistance of the discarded direct current." This view seems entirely sensible, and it is entitled to consideration as a protest from a practical electrical engineer, not deficient in theoretical knowledge, but not allowing purely theoretical considerations to weigh unduly against practical experience.

"We know that one of the principal objections to the alternating current is the increased difficulty of transmission, and yet we transmit energy by this system, and at the receiving end convert it into a direct current, so that we may be able to make use of it. Would it not be a wiser policy to rectify the current before transmission, and thus save, either in cost of construction, wire, or in higher efficiency of transmission? If it would be wise to go that far, would it not be still wiser to go one step further, and replace the alternator with a direct-current generator, and thus save the extra loss in transformation as well as in transmission? Obviously the correct answer to these questions is that, if the direct current can be successfully used at as high an electromotive force as the alternating, it would be the best one adapted to our requirements."

As to the respective costs of the two systems, "the direct current is the cheaper for all line construction," the cost for both copper and insulation being smaller. An alternating generator dispensing with commutators can be made for less cost than a direct-current generator. "But an alternator by itself is not a complete machine; it must have an exciter, the cost of which would be greater perhaps than that of the commutator of a direct-current generator of equal capacity. The alternator can be made self-exciting, but it would require a commutator, and its cost then would be about the same as that of a machine with a separate exciter."

The respective costs of the two systems, therefore, are not so materially different as to have much influence upon choice between them; but Mr. Baxter maintains that for either light or power the cost for installing the alternating system is the greater. He admits that the latter can be cheapened by discarding the step-up transformers, but not enough to place the two systems on equal footing as to cost. He also admits the possibility, and even the probability, that encumbrances that now embarrass the alternating system may yet be found unnecessary, though he thinks step-down transformers must be used for lighting, their avoidance in buildings supplied with current for lighting being possible through the use of larger step-down transformers in substations. "In such an arrangement the primary would go to the transformers in substations, and a secondary of, say, one hundred and ten volts could be derived for commercial purposes."

Now, as the costs of the two systems do not vary sufficiently to establish the supremacy of the direct current with an equal number of transformations, the author admits that this supremacy can be established only by demonstrating the practicability of using with it a higher electro-motive force. He believes this can be done with safety, and the first part of his paper terminates with this assertion. In the second part of the paper (*Electrical Engineer*, Dec. 18), he considers methods whereby this result can be practically achieved, and makes, in substance, the following propositions: (1) the limit of electro-motive force that can be used in either system is the insulation; (2) the pulsating electro-motive force is more trying to the insulation than the steady force of the direct current; (3) if an alternating current of a given electro-motive force can be insulated, a direct current of higher electro-motive force can be retained by the same insulation; (4) as the maximum E. M. F. of the alternating current is about forty per cent. higher than the effective E. M. F., the same insulation that will hold an alternating current with an effective E. M. F. of ten thousand volts would hold a direct current of fourteen thousand volts.

As to sparking of commutators, he says: "There is no difficulty whatever, in my judgment, in constructing a constant potential generator for fifteen or twenty thousand volts that will not spark on the commutator. All that is required is to so proportion the parts that the difference of potential between the commutator sections at the points where the brushes bear will be so low as to be incapable of making a spark. It may be said that machines made for such high electromotive force, unless of very large capacity, would require very fine wire for the shunt coils. But, in answer to this, it may be said that it is not necessary to use shunt coils. The same results can be obtained in other ways, which admit of the use of large wire."

If it should be found impracticable to construct generators of fifteen or twenty thousand volts, the same electromotive force in the line can be obtained by the use of a number of generators having a less E. M. F. and coupled in series. The smaller machines would cost more than the large one, but Mr. Baxter holds that the total cost for a given capacity in a direct-current plant would not be greater on this account, as the same amount of copper would transmit 40 per cent. more energy with the direct-current system.

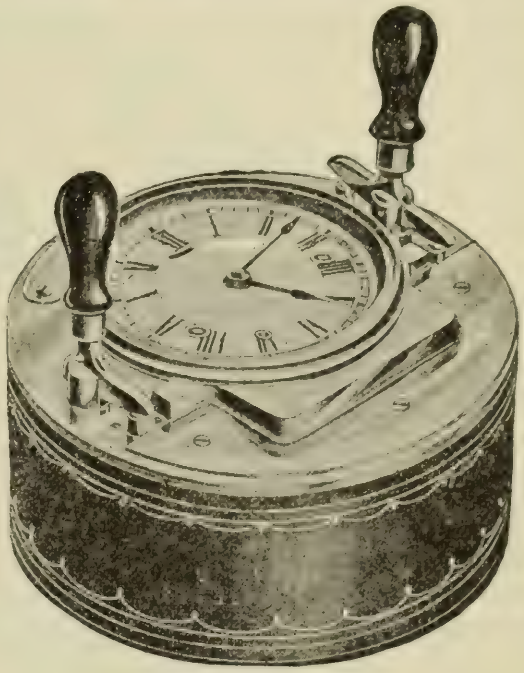
The advantage claimed for the alternating system—that its "transformers are immovable masses of metal"—is only true in the case of lighting. Rotating transformers, nearly the same in design and cost as those used for direct current, must be used for power.

Commutators are now very durable parts of generators. Mr. Baxter says there are a great number of railway generators, the commutators of which (at the rate of wear under which they have worked for three years) would last thirty years. These facts certainly make a strong argument in favor of the direct current, and they will remain weighty until some further decided advance in the alternating-current system shall have been made.

The Calculagraph in Telephone Service.

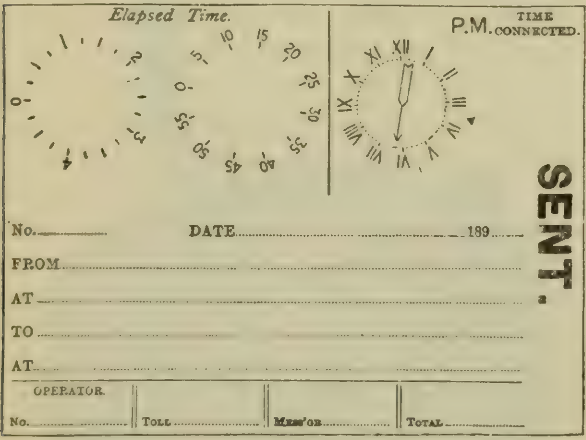
SOME of the difficulties in adjusting payments for telephone service, although familiar enough to experts in the art of telephony, are not known to the general public, and an account of them in *Western Electrician* (Dec. 21) is of general interest. It needs no argument to prove that a customer who occupies materially more time at the instrument than another should pay more for the service. The time of use varies very much,—say from forty-five seconds to ten minutes. How to adjust tolls to the different times of service at telephone exchanges may seem a simple problem, but it has not been found to be such by the telephone companies. The following is an abstract of this interesting article:

An idea of the trouble that was encountered can be gained from the experience of one eastern exchange, where a determined effort was made to devise a scheme by which the time occupied in conversation would be an important factor in the cost of the service. When the new rule was introduced, the chief operator discovered that during the busy parts of the day operators were in the habit of making half-a-dozen connections before recording any of them. An inspection of the cards showed in some cases that one operator would make six to ten connections at exactly the same time,—according to the records in the company's office upon which it was necessary to compute the bills of subscribers. This, of course, was an impossibility, but it seemed equally impossible to correct the practice. In one case this was explained by the fact that the clock in the operating-room was located in an inconvenient position, and most of the young ladies were obliged to turn about and look at the clock each time they received a call, if they were to comply with the requirements of the company. Taking advantage of this experience, another exchange, also in an eastern city, purchased a large number of stop-watches for its operators, but this only partially overcame



CALCULAGRAPH. FIG. I

the difficulty. The main objection to the scheme was the absence of some accurate and reliable method of recording the actual time of conversation, so that it could be demonstrated beyond question, not only that the service was given, but that it was furnished at a certain time. To those who have had experience in long-distance service or in exchanges centrally located, from which many lines extend out to neighboring towns and villages, and where the business interests and social life of these numerous communities are so interwoven as to be practically a unit, the importance of this problem will be at once apparent.


Elapsed Time.

P.M. TIME CONNECTED.

SENT.

No. ______ DATE ______ 189___

FROM ______

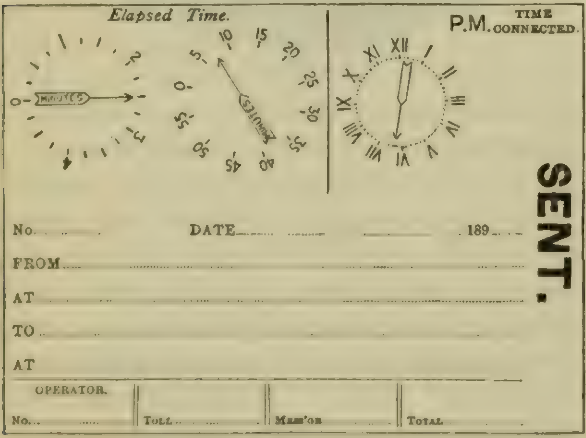
AT ______

TO ______

AT ______

OPERATOR. No. ______	Toll ______	Mess'gr ______	Total ______

FIG. 2.


Elapsed Time.

P.M. TIME CONNECTED.

MINUTES
SECONDS

SENT.

No. ______ DATE ______ 189___

FROM ______

AT ______

TO ______

AT ______

OPERATOR. No. ______	Toll ______	Mess'gr ______	Total ______

FIG. 3.

About two years ago it was proposed to introduce the calculagraph into this service, and arrangements were made to conduct extensive experiments in a New York exchange. Several instruments were placed in actual service, and during the last year they have been relied upon absolutely, not only in "long-distance" service, but in the "toll" department of the local service. In the accompanying cuts, Fig. 1 shows the appearance of a single instrument completed and ready for service (as used by the American Telephone and Telegraph Co., New York). The calculagraph is a combination of a clock and recording apparatus, by which mechanical calculations and printed records of the net results are made. Tickets are used upon which the several records required are stamped. Specimen records are shown in Figs. 2 and 3, these cuts being reproductions of tickets used by the Central Union Telephone company; and in Figs. 5 and 6 two additional forms are given, by which it will be seen that calculations of money earned at any standard rate per unit of time can be produced as readily as the record of the time occupied in a telephone conversation. This, it will be readily understood, makes the instrument applicable to many fields, including messenger service, billiard and pool rooms, livery, bicycle, and boating companies, as well as in factories and shops employing many operatives and clerks.

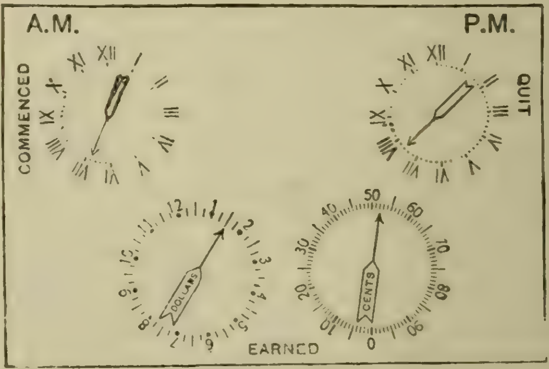


FIG. 4.

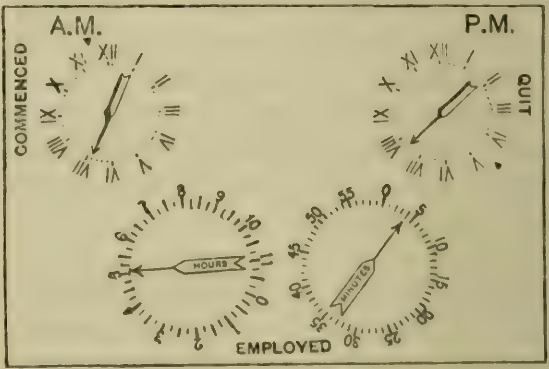


FIG. 5.

It is admitted by the large exchanges that thus far the instrument has met all the requirements of service. It can be used by operators without special training, as the method of operation is very simple. At the beginning of a message the ticket is inserted in the slot at the front of the instrument against the guide, and is shoved to the right until it fits in the corner. The right-hand lever is then pushed backward and forward; this records the time of day, and also makes an impression of the two dials at the left, but not of the pointers. At the end of the message the ticket is again inserted in the slot in the same position as before, and the left-hand lever is pulled forward, thus printing in the center of the two left-hand dials the two pointers, indicating the figures which represent the exact length of time that has elapsed since the first impression.

Thus these instruments record the time of day a connection is made for a conversation; the time which elapses between the first "ring-up" from the subscriber or the local exchange and the time when the person wanted at the distant city comes to the receiver and communication is completed between the two persons who wish to talk; the time which elapses during the actual talk, on which the charge is based according to the distance covered; and the time which elapses during an interruption of a conversation from any cause, so that the interrupted time may be deducted from the total elapsed time in making the charge to the customer.

New Telephonic Improvements.

A LETTER from a Boston correspondent to the *Electrical Review* (Dec. 11) indicates that in this art the end of improvement has not yet been reached. The statement is made that the National Telephone Manufacturing Company has made some improvements, exemplified by the instalment of a new telephone exchange in Mobile, Ala., "which have proved an eye-opener to many interested parties." The instalment was made for the Home Telephone Company of Mobile, and is said to comprise "a number of important special devices put into practical operation here for the first time in an exchange. The switchboard already installed and now in operation has a capacity of eight hundred drops, five hundred of which are in use. No metallic circuit construction has been necessary, induction coils have been dispensed with, and yet the service is completely free from all induction or cross-talk. These are points which cannot fail to interest every practical telephone man in this country.

"The instruments themselves consist of a small portable telephone only nine inches in length, and a magneto-bell-box about three and one-half inches cube. The telephone is simply a receiver and transmitter in combination. Pressing a key in the handle of the combination throws the drop at 'central,' and subscribers are able to communicate with each other in less time, while the system itself is more economical than anything now in use elsewhere."

The system is stated to be immensely popular with the Mobile public, proof of which is cited in the fact that the Home Telephone Company has given an order to the National Telephone Manufacturing Company to increase the instalment to twice its present capacity.

Another innovation made by the National Telephonic Manufacturing Company supplies a need for the better operation of trolley lines. By it the conductor of any car can at any time put himself in communication with headquarters, or with the power station, in case of a break-down or other emergency wherein he needs either aid or instructions. This device is thus described. "It consists merely of an ordinary No. 10 iron wire strung along the poles over the entire system, starting from and returning to the power house. Connected with this wire and at convenient distances apart are little water-tight switch boxes fastened on the poles. Each car is provided with a small portable combination receiver and transmitter, connected by a short cord to a contact plug. In the event of accident, the conductor can cut into the nearest switch box, press the key in the handle, and communicate immediately with headquarters. The few batteries necessary for the working of the line are located at the power house, and the whole outfit to be carried may be put into a coat-pocket."

The advantages of such a system are obvious to any one at all conversant with the operation of trolley lines, and one can well imagine circumstances under which many times the cost of such a simple apparatus might be saved in a single year, or even a much less time.

Chronograph for Trolley Roads.

STILL another step in advance in the working of trolley roads has been made by a superintendent of a western trolley railroad. If well carried out, this device ought to be of great assistance in the control of a trolley line. It affords a means whereby the position of every car on the line may be known at all times at headquarters and in the power houses, so that, if, by reason of any obstruction, the cars get bunched on the line, this fact becomes known immediately to the persons in charge of the road. If any car gets crippled and is thus delayed, the fact that it has not reached a definite point at the proper time is known at once by those in authority. The device is described in *Boston Journal of Commerce* (Dec. 14).

" The chronograph consists primarily of a sheet of paper moving at a uniform rate under a series of pens or points, operated by magnets. Each magnet point represents a point on the road, and each time a car passes this point on the road it makes contact, and the magnet point on the chronograph makes a prick mark on the paper. The arrangement of parts is as follows: on the frame is mounted the back roller to hold a supply of paper, the front roller on which to roll up the record, the top plate holding the magnet points, and the top roller which gives the time movement to the sheet. The top roller is a series of grooved wheels, one for each magnet point. This is one of the most important parts of the device, as the movement of the sheet must be absolute and exact, or the time record will be inaccurate. This roller is operated by a high-class, powerful clock movement, which moves the time roller one revolution per hour. This is proportioned to give the paper exactly four inches of movement per hour, or one inch for every fifteen minutes; a line running on a one-minute schedule will, therefore, show fifteen cars or prick marks to the inch, a five-minute schedule three to the inch, and so on. A break of two inches would show a stoppage of thirty minutes at that point, and a record showing even, regular points indicates that cars are running all right at that point of the road. These sheets are dated and filed for reference, and thus a record of the operation of the road is kept, and improvement in service is bound to result from the information thus obtained."

Dry Batteries.

TWO forms of dry batteries which are simply modifications of the Leclanché primary battery are in the *Electrical Engineer* (London). The cuts herewith show the arrangement. The battery shown in Fig. 1 consists of a zinc vessel, D, forming one electrode and containing a black paste, *B*, in which is embedded the carbon electrode, *A*, and a white paste, *C*, surrounding the black paste. The formula for the black paste is as follows, the numbers giyen being parts in a total of 10,000:

Manganese dioxid, 757; carbon, 4,726; magnesia, 720; lime, 140; peroxid of iron, 212; ammonia, 1,278; water, 977; ingredients not determined, 1,190.

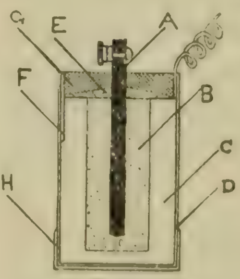


FIG. 1

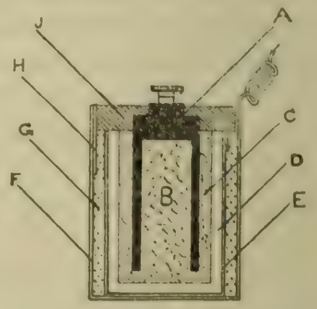


FIG. 2

The white paste consists of lime, 2,089 parts in 10,000; ammonia, 2,029 parts; chlorid, 631 parts; water and binding material, 5,251 parts. A thin layer of silicate cotton, *E*, is placed over the pastes, and the cell is then sealed with pitch. Gas escapes through F.

The other form, shown in Fig. 2, consists of a zinc vessel, *E*, contained in a pasteboard cylinder, F, and surrounded by sawdust packing, *G*. The carbon electrode, *A*, is made in the form of an inverted cylinder, and the interior is filled with silicate cotton, *B*. Around the outside of the carbon cylinder is placed a paste, *C.* This paste consists of the following ingredients,—parts in a total of 10,000:

Manganese dioxid, 2,554; carbon, 1,602; silicate, 1,276; magnesia, 1,288; lime, 96; peroxid of iron, 346; moisture and ingredients not determined, 2,838. The white paste, D, consists of lime, 2618 parts; oxid of zinc, 600 parts; magnesia, 0.51 parts; ammonia, 249 parts; water and binding material, 6,482 parts.

This white paste forms a lining to the zinc cylinder, *E*, which is, of course, the negative electrode. A stout wire is soldered to the zinc cylinder to form a terminal, and the carbon is also provided with a brass terminal screw and nut. A waste tube, *H*, is provided, and the whole is sealed with pitch *J*.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals— See Introductory.

Lighting.

3020. Illumination vs. Glare. Albert Scheible (Consideration of light for the shop window, the home, and the street). Elec Eng–Dec. 11. 1700 w.

3128. Arc Lighting Progress. Alex. Dow (Reviewing the progress made in arc lighting during the last two years). Elec Engng–Dec. 3800 w.

3135. The Luminosity Limit of the Hydro-Carbon Flames. W. H. Birchmore (The first part treats of the changes produced in hydrocarbons by heat, and the physical changes involved in breaking a molecule). Elec Eng–Dec. 18. Serial. 1st part. 1700 w.

*3210. The Incandescent Lamp Question (An account of an interview with Messrs. Binswanger and Robertson, with tables). Ind & Ir –Dec. 13. 1100 w.

3249. Tests of the Moore Regulating Lamp Socket. William A. Anthony (Descriptive of two methods for decreasing the intensity of illumination in electric lights, with table showing results of experiments made to determine the comparative energy saved). Elec Eng–Dec. 25. 1000 w.

3250. Selection of Steam Engines for Electric Lighting Plants. Francis B. Crocker (The importance of the question. The proper size, number and type &c.). Elec Eng–Dec. 25. 2400 w.

3251. Loss of Revenue Due to Transformer Leakage Current. Spring S. Armstrong (Showing the poor economy of cheap transformers, and urging the use of the largest transformers possible, looking beyond the immediate future for economies to be effected). Elec Eng–Dec. 25. 1800 w.

*3308. Walsall Electricity Works. Ill. (Historical and descriptive). Elec Eng, Lond–Dec. 20. 5500 w.

*3311. The Development of a Low Pressure System. Ill. (Descriptive of the new works of the St. Pancras Vestry). Elec Rev, Lond–Dec. 20. 4500 w.

†3313. Practical Experience with Storage Batteries in Central Stations. C. L. Edgar (A paper read in the discussion of the storage battery before the Soc. of Elec. Eng. The author considers the uses to be 1. to carry the peak of the load at maximum hours; 2. to carry the entire load at minimum hours; 3. to act as an equalizer or reservoir; 4. for the equipment of annex stations). Trans Am Inst of Elec Eng –Nov. 3300 w.

*3316. The New 1000-Unit Machine at Deptford. Ill. (General remarks on the difficulties encountered by the London Electric Supply Corporation, followed by a description of the new engines). Eng, Lond–Dec. 20. 5400 w.

3503. The Mistaken Ideal of Artificial Light Improvers. W. H. Birchmore (Criticism of the work of Palaz, and a discussion with the object of showing that it is not in the dicta of a Bunsen photometer that we must find our standards, but in the brightness of certain colors and in the "spectra of reflection"). Elec Eng–Jan. 1. 2400 w.

3526. Central Station Working. Ill. Cecil P. Poole (The first part treats of combining steam and water-power electric plants). Elec Wld–Jan. 4. Serial. 1st part. 2200 w.

Power.

3014. A Giant Electric Crane. Ill. (Description of a high-speed electric hoisting and conveying machine used in ship-building. The Brown balanced cantilever electric ship-building crane at Newport News, Va., remarkable for its size, capacity, and the speed at which it travels). Elec Rev–Dec. 11. 1200 w.

3019. Eddy Motors in the Campbell Wall Paper Factory, New York City (Illustrated description of one of the most recent interesting examples of the substitution of electricity for the counter-shaft). Elec Eng–Dec, 11. 900 w.

3028. Power Plant of the Niagara Falls Hydraulic Power and Manufacturing Company. From *Canadian Journal of Commerce* (Descriptive). Power–Dec. 800 w.

3045. Storage-Battery Manipulations at the Boston Edison Station. Ill. (A description of the method of switchboard manipulations). Elec Wld–Dec. 14. 900 w.

*3097. Canet's Electrically Worked Turrets (Description with illustrations showing the arrangement of the turret, mountings, training gear, and ammunition hoist on board the Skjold). Engng–Dec. 6. 800 w.

3107. An Invention that Keeps Track of Electric Cars While in Operation (A system of chronographic recording by which the position of trolley cars can at any time be known at headquarters or at the power-house). Bos Jour of Com–Dec. 14. 400 w.

3145. A new Design of Multipolar Dynamo. Ill. (A design built by the Triumph Electric Co. of Cincinnati. The chief point of superiority claimed is the construction of the magnetic circuits by which a greater efficiency is obtained). Elec Ind–Dec 500 w.

*3230. The Use of Dust Destructors as Steam Producers for Electricity Supply Stations. E. Manville (Paper read before "The Northern Society of Electrical Engineers." A description of the two installations being erected for the Vestry of Shoreditch and the Corporation of Swansea on what the writer believes to be the most suitable lines). Elec Plant & Ind, Lond–Dec. 1. 6000 w.

3245. The Evolution of an Electric Motor. Ill. Edward B. Rosa (A brief sketch of the evolution of the motor, as shown by a series of lecture experiments). Chau–Jan. 4000 w.

3261. The Electric Self-Playing Piano. Ill. (Descriptive of an apparatus for attachment to any ordinary piano, enabling it to be played by electricity without the intermediation of any performer). Sci Am–Dec. 28. 800 w.

†3314. Past and Present Obstacles in the Storage Battery Development. Carl Hering (A paper read in the discussion on storage batteries). Trans Am Inst of Elec Eng–Nov. 3500 w.

†3315. Past Experience with Storage Batteries (Remarks by Frederick Reckenzaun, followed by general discussion of all the papers read on the storage battery question). Trans Am Inst of Elec Eng–Nov. 10800 w.

*3318. Electric Welding. Ill. (Describes a series of experiments carried out by the London Electric Supply Company at its works at Deptford. The examples of work done are very interesting. The welder was a 40 kilowatt, weighing 2800 lbs., with a primary current of 300 volts. The ratio of winding, of primary to secondary, was 300 to 1). Eng, Lond–Dec. 20. 700 w.

3383. A Suspended Beam Electric Tramway. Ill. (A modern method of handling furnace covers in a carbon plant). Elec Rev–Jan. 1. 1000 w.

3400. Storage-Battery Traction. J. Sarcia (The first number treats of recovery of energy, and calculation of the traction coefficient). From *L'Industrie Electrique*. Elec Ry Gaz–Dec. 28. Serial. 1st part. 1500 w.

3450. Electricity in Iron-Working (Discussing economy in motors, and examples of their use in iron works, with the methods of connecting). Ir Tr Rev–Jan. 2. 2500 w.

†3463. Some Recent Generators and Motors (Illustrated description of the generators and motors recently put upon the market by the Walker Manufacturing Company of Cleveland). St Ry Jour–Jan. 2800 w.

3514. Features of the Portland Transmission Hitherto Unpublished. Ill. George P. Low (Scheme of distribution for lighting and power circuits, and other interesting features). Jour of Elec–Dec. 1900 w.

3527. Notes on Accumulator Testing. Carl Hering (The object of the article is to point out some of the more important conditions under which tests are to be made, and to give hints regarding the carrying out of such tests). Elec Wld–Jan. 4. Serial. 1st part. 1800 w.

Telephony and Telegraphy.

3059. The New Home of the Postal Company at Chicago. Ill. E. J. Nally (Brief history of the progress of the Postal Telegraph-Cable Company, with description of their new building in Chicago). W Elec–Dec. 14. 5400 w.

*3133. Multiplex Telephony. Kempster B. Miller (A brief account of what has been done in this field). Sib Jour of Engng–Dec. 1200 w.

3136. Experimental Use of the Essick Page Printing Telegraph for Transmitting Information in Sea-Coast Artillery Firing, 1895. H. C. Carbaugh (Abstract from the *Journal of the U. S. Artillery*. Description of the test, with illustrations of the transmitter and receiver). Elec Eng–Dec. 18. 700 w.

3146. The Calculagraph in Telephone Service. Ill. (Describes an instrument for recording the time a telephone is in use). W Elec–Dec. 21. 1200 w.

*3227. Electrical Communication between Moving Trains (Descriptive of means of communication between passing trains, the object being to preserve a given space between those travelling on the same pair of rails). Elec Rev–Dec. 13. 400 w.

*3229. The Amazon Cable (An account of the work, about to be commenced, of laying a cable in the bed of the river, as the rapid growth of vegetation in tropical countries renders the maintenance of overhead wires very costly. Map). Elec Eng, Lond–Dec. 13. 500 w.

*3247. The New French Atlantic Cable (An abstract of the agreement in connection with the proposed new cable from Brest to Cape Cod). Elect'n–Dec. 13. 1300 w.

3262. The Cable Repair Steamer Mackay-Bennett. Ill. (Descriptive of a fine steamer owned by the Commercial Cable Co.) Sci Am–Dec. 28. 1500 w.

3382. The Hunnings' Transmitter (Statement by the Rev. Henry Hunnings). Elec–Jan. 1. 1000 w.

*3505. The Government of Norway and the Telephones. Alfred R. Bennett (Considerations which led to the decision against state acquisition of telephones). Elect'n–Dec. 27. 1800 w.

†3508. A New System of Machine Telegraphy. Patrick B. Delany, with Discussion (Touching upon the obstacles in the way of practical high-speed telegraphy, and explaining how, in the writer's opinion, these difficulties can be surmounted). Jour of Fr Inst–Jan. 3800 w.

3523. Telephone Service on Electric Railways. Ill. H. G.T. (The system installed by the National Telephone Manufacturing Company, of Boston, on the line of the Braintree and Weymouth road—its construction and operation). Elec Rev–Jan. 8. 900 w.

*3535. Mechan & Sons' Triple Automatic

Reply Ships' Telegraph (Illustrated description.) Steamship-Jan. 500 w.

†3547. Cable-Repair Ships of the World and Their Work. Ill. Gustav Heinsohn (An historical account of what has been accomplished in this field, the difficulties overcome, and many points of interest). Ind Rub Wld-Jan. 10. 2800 w.

Miscellany.

*3012. The Commercial Exploitation of Electricity. Burton E. Greene (Showing how the mania for speculation has prevented the electric light and power industries profitable commercial returns). Eng Mag-Feb. 5000 w.

*3083. Note on Tinfoil Grating as a Detector for Electric Waves. T. Mizuno (From the *Journal* of the College of Science, Imperial University, Tokio, Japan. An account of experiments and a few tests of the sensibility of tinfoil grating as a detector of electric waves). Elect'n-Dec. 6. 1500 w.

*3130. Simple Analytical Theory of the Transformer. Frederick Bedell (Mathematical). Sib Jour of Engng-Dec. 1200 w.

3133. Electricity at the National Capital. George H. Drayer (An account of changes recently made, or soon to be made, in the Capitol at Washington, for utilizing electricity in many ways). Elec Rev-Dec. 18. 1100 w.

3134. Charging Storage Cells for Signalling Purposes. A. S. Hubbard (Illustrated description of a switch, which, operated by the starting and stopping of the dynamo, automatically changes the sets). Elec Eng-Dec. 18. 400 w.

3137. Put a Premium on Safe Wiring. Edward H. Johnson (Paper read at the meeting of the Underwriters' Nat. Elec. Assn. Favoring iron armored conduits). Elec Eng-Dec. 18. 1200 w.

3142. Changes in Underwriters' Rules (Result of the work of the Electrical Committee of the Underwriters' National Electrical Association, providing for a number of changes and additions to the present code of inspection rules of that body). Elec Wld-Dec. 21. 1700 w.

3143. New Features in Electric Advertising. Ill. (Descriptive of some of the ingenious devices produced by electricity). Elec Wld-Dec. 21. 1000 w.

3144. Frequency-Changing and Single-Phase Alternating-Current Motor Transformers. Ill. F. Jarvis Patten (Explanation of the general system, and describing a system in which it is claimed the magnetic effects will be found almost constant). Elec Wld-Dec. 21. 1200 w.

3165. Electric Registering Water Level Indicator. Ill. (Description of a registering indicator recently brought out by The India Rubber, Gutta Percha and Telegraph Works Company). Sci Am Sup-Dec. 21. 1200 w.

*3228. Crompton Improved Bifilar D'Arsonval Galvanometer (Illustrated description). Elec Eng, Lond-Dec. 13. 1200 w.

3277. Electricity at the Atlanta Exposition. Ill. Charles F. Foster (Full description of arrangements for lighting, and electrical exhibits). Elec Wld-Dec. 28. 4500 w.

3294. Use of Static Electricity in a Bottle-labeling Machine (Illustrated description). W Elec-Dec. 28. 1800 w.

3295. Tendencies of Modern Electrical Research. M. I. Pupin (An address delivered before the N. Y. Acad. of Sciences. Tracing the development of the science of electricity, and showing how the domain of electricity is being extended). Science-Dec. 27. 10900 w.

*3312. The True Resistance and Back E. M. F. of the Arc. W. E Ayrton (Pointing out some errors of Silvanus Thompson, with explanations). Elec Rev, Lond-Dec. 20. 2000 w.

*3353. The Electrical Patents of 1894 (Electrical patents granted in this year by the United Kingdom, United States and Germany, number 3315. The number granted in each country is given; also those applying to the different branches). Engng-Dec. 20. 700 w.

*3360. Notes on an Investigation of the Alternating Current Arc. J. A. Fleming and J. B. Petavel (Results obtained in investigations recently carried on in the electrical laboratory of University College, London). Elect'n-Dec. 20. 3500 w.

*3361. Speed-Voltage Curves. J. Alfred Griffiths (A method of investigation useful to students and of interest to experienced electricians). Elect'n-Dec. 20. 2500 w.

†3374. The Electric Furnace in Chemistry. M. H. Moissan. Translated from *La Nature* (A review of the work accomplished by the use of the electric furnace, and showing that it is having an important effect on the industries). Pop Sci M-Jan. 1200 w.

*3415. The Geometrical Form of Transformer Plates. George Adams (Treating of the best form of plate, with illustrations and comments). Elec Rev, Lond-Dec. 27. 900 w.

*3416. Energy Losses in Dielectrics (A review of the work done by investigators of this subject). Elec Rev, Lond-Dec. 27. 1200 w.

3441. Electrotechnics. Ill. Frank S. Mason (Will cover the science of the methods, processes and operations in which electricity is applied in the industrial arts, the relations between electricity and magnetism, and the phenomena due to those relations. The first part contains a brief historical sketch, a list of units, and a criticism of the definition of the watt, as given in Houston's electrical dictionary). Am Mach-Jan. 2. 1800 w.

3456. Electrical Development in the South (The record of the year comprehensively reviewed; interesting electrical installations; applications of electricity in industrial operations). Tradesman-Jan. 1. 7500 w.

*3506. Electrodynamic Rotations Produced by Means of Alternate Currents. Galileo Ferraris, with Editorial (A paper read before the Turin Academy in 1888, and translated at this late date because of its importance to many readers). Elect'n-Dec. 27. 4500 w.

3525. D'Arsonval's Treatment for Electric Shock (Abstract of report of committee of electrical experts appointed by the Paris Academy of Medicine). Elec Rev-Jan. 8. 1200 w.

INDUSTRIAL SOCIOLOGY

Both Sides of Profit-Sharing.

THIS subject is treated interestingly in Appleton's *Popular Science Monthly* for January by Mr. Frederic Mather, who sees no immediate prospect of ending the contest between capital and labor, and who maintains that "the establishment of boards of arbitration will not meet present difficulties. That which one side calls reasonable and equitable will often be considered unreasonable and inequitable by the other side, and arbitration will not change the opinions of the defeated side. When it results in a compromise, it generally suits neither party to the controversy, because in such cases both sides have relinquished something that they think should, in justice, have been accorded to them.' Mr. Mather's opinion is that "the fatal defect in treating the labor problem . . . . has been the stress laid upon change of method," whereas it is a change of spirit in both parties to the controversy that is needed. Quoting Dr. Channing, he accords with the view of that eminent divine that "the only elevation of a human being consists in the exercise, growth, and energy of the higher principles and powers of his soul," and thinks that, while the only practical way in which this can be brought about is by the system of profit-sharing, even this method is practicable only within certain limits.

A number of examples of profit sharing enterprises are adduced to show what has been and can be done in this way. Some of the most successful attempts at applying this system have been in France.

"In 1844 the Paris and Orleans Railway Company adopted the principle. Between 1844 and 1882 about twelve million dollars were distributed as profit dividends among the employees, while the wages paid to them were equal to those paid by roads that gave their employees no share in the profits; and at the same time the dividends to the stockholders were as large as they would have been, had there been no profit-sharing. Students of political economy are familiar with the Ateliers Socialistes of Paris. Many of the smaller enterprises in the same city have also applied the system of profit-sharing with remarkable success, one of the most conspicuous being the Atelier de Broderies of M. Nayrolles. In this establishment the system is carried out among a *personnel* composed exclusively of women, and with astonishing results both with the quality of the work and the increased wages of workers."

The example thus set has been recently followed in England and in America. Of these a number of examples—that is, of experiments which have succeeded up to the present time—are cited. Chicago, that wonderful city of rapid growth and prodigious enterprise, has several profit-sharing establishments, and others in New York and Philadelphia are named.

"After several experiments in other lines, a publishing house in Chicago adopted profit-sharing about fifteen years ago. The house has increased its capital stock more than once; and many of its men, who were ordinary workmen under the old system, now own their homes and are worth from five to fifty thousand dollars each. In another establishment, also in Chicago, those who had been in the employ of the company for one year or more were informed that, if the amount of their sales for six months should exceed the total for the same period of time in the previous year, they would be allowed a commission on the excess. The commission averaged 2½ per cent. The employees at once increased their efforts to sell; and, when the first distribution was made, last July, it was found that several of the girls had nearly one hundred dollars as their share of the profits for six months."

The author does not, however, regard these and other attempts at putting the system of profit-sharing into practice as conclusive that it will or can become universal, notwithstanding the obvious benefits it confers in times of prosperity. Profit-sharing enterprises have yet to pass through the fires of adversity to prove what power of endurance they possess. The case is thus put by Mr. Mather:

"But can any one guarantee to the employer that every year willl be a profitable one? And, if there are losses, who shall make them up? Shall the employers make them up by themselves, or shall the men, having once been taken into a partnership upon the profits, still continue that partnership by making up their share of the losses? There are many employed men who are the owners or the partial owners of their homes. They would gladly enter into an arrangement for the division of the profits, but they would hesitate to mortgage their homes as security for their proportion of the losses in a bad year. Other employees could offer no security whatever in such a case; therefore, the losses must come upon the employers in the end. It is this fact, more than any other, that hurts the prospects of profit-sharing. Such an arrangement can not be in the nature of a true partnership, because, as noted above, there is a partnership so far as the gains are concerned, but the partnership ceases when there are losses. Hence, as at present tried, the system of profit-sharing is really a gratuity on the part of the employers, most of them having taken the ground that they must average their good years in order to keep their men employed uniformly."

The lack of a contingent fund to tide the employer over bad years is noted as a weakness of the system. The small effect of the system in increasing sympathy between employers and employed is also noted, and the conclusion is reached "that neither profit-sharing nor any other device will improve the present situation, so long as there is a lack of sympathy in either side toward the other. The employers and the holders of great wealth should regard themselves, not as mere irresponsible giants of finance, but as sacredly responsible to society for the large interests that have been intrusted to them. The too frequent want of such a broad idea of his functions has led the public to believe that the capitalist is a man who absorbs all the toil of the laboring man, leaving to the latter a very uncertain subsistence. Nor does the capitalist have credit for the fact that, without him, labor would not be so productive, and for the further fact that his share is taken from a product that was created largely through his direction, his enterprise, and his resources. It makes a vast difference whether an army has a skilful general at the head, or only an ordinary leader"

Finally, unless both capitalists and workmen come to regard every kind of honest occupation as honorable, "neither profit sharing or any other form of effort will be able to bridge the chasm."

Profit Sharing.

IN line with the preceding review, an editorial on "Experience with Profit-Sharing" (*Engineering*, Dec. 27) takes a commanding view of the system and its present status in the world's industry.

The system is regarded as ideal in the principles of equity upon which it is based. The simplicity of the scheme attracts attention. Its ready application also commends it; yet the fact remains that a large majority of attempts to apply it have failed. A few successes may be scored on the credit side of the account, but the permanency of these successes, in view of the failures, the inherent nature of trade, and the characteristics of human nature, is still problematical.

"The experience of years is told in part by a report lately issued from the labor department of the board of trade. It can scarcely be said, after careful perusal of the report, that hopes have attained fruition. In the first place, profit-sharing, as first conceived, has been found almost impracticable, and, where possible, has been without appreciable result. Only the most sympathetic expected that it would be otherwise. The conditions required a mental, if not a moral, training which the weekly or fortnightly wage did not inculcate. Reward quickly follows efforts in the case of the ordinary wage; in the other, it is so remote as to prove no incentive, except to the more thoughtful and energetic workman. And, after a time, even his enthusiasm is affected by the lack of interest of his neighbor. 'To a man living from hand to mouth, the hope of receiving a reward at some distant period offered but little inducement towards higher efficiency.' That is the view suggested by experience to Mr. Towne, of the Yale and Towne Company, Stamford, Conn. It was thought that this lack of interest in deferred results would be less operative in small works employing twenty persons. The system was adopted in 1893, when the bonus was 10 per cent. In 1894, it was 1.65 per cent. The basis was the same; the difference 'is accounted for only by the fact that the men did not work so hard.' That is the view of the firm in question. Again, in a skin-dressing factory the departments were divided, and the amount of bonus was based on the saving in production in each. Thus, in 'dressing,' the men earned 7½ per cent.; in dyeing, 10 per cent., in finishing, 5 per cent.; and in fellmongering, about 8 per cent.,—in the first year (1890). But since then no bonus has been earned. In regard to the effect of the system, the firm write that the result was fairly satisfactory, but, in consequence of the system possibly, one department was over-jealous at first of another's large bonus, and the indifference subsequently was rather marked.

"This element of jealousy, in cases where profit is credited to separate departments, is most pronounced in individual work or in small groups, and is almost fatal to any scheme, for it begets the feeling that there must be unfairness in any arrangement which admits of one man earning a larger bonus than another. It is idle to offer explanations to the men, since a full statement cannot be given. The disclosure of a firm s financial affairs to the workmen would be injudicious, and this fact tends to make any profit-sharing scheme a one-sided arrangement. On the one hand, faith is commanded; on the other, a strong will against temptation. But to counterbalance this there is the still more unsatisfactory one-sided arrangement that all profit is shared, while the loss is borne by the employer."

The inference is plain that, unless profit-sharing shall be extended to loss-sharing, including the latter as rigidly and inexorably as the former, and that, unless workmen can be admitted to a share in management, at least to an extent that will satisfy them that such management and its record in the counting-room is as much in their own interest as in that of the heads of the establishment that employs them, seeds of discontent will exist, ready to germinate into a crop of disturbance as soon as favoring conditions for its growth are established.

The sort of half partnership involved in any system of profit-sharing yet put into operation cannot, however it may temporarily succeed, ever take the place of real and complete partnership. While admitting the equity of profit-sharing, we, therefore, hold that, if principles of justice are to rule, other equities must be considered, and that, however successful an experiment in profit-sharing may appear to be, these other equities will in the end force themselves to the front as elements no longer to be ignored. The system, moreover, has other limitations.

We fully concur with *Engineering* in the belief that what is called "gain-sharing" must necessarily be confined to such work as is repeated indefinitely, with few alterations. This system contemplates the sharing of gains after losses are deducted from gross profits. But many of the difficulties inherent in profit-sharing will cling to a gain-sharing system as well. For instance, losses might occasionally be so large as to more than absorb the total profits, thus creating a deficit. It is easy to foresee what discontent would be aroused under such a condition. The objection that a true partnership does not exist, unless the workmen are admitted to the secrets of the counting-room and private office and to participate in the management, is just as forceful in the one case as in the other.

Engineering remarks, concerning an experiment in gain-sharing made in 1887 by the Yale and Towne Manufacturing Company, that it "had several recommendations. In the first place, the reward was paid monthly. It was based on a liberal scale of standard costs, and was put into operation for five years, both of which were recorded as essential conditions to encourage the men to do their best, in the knowledge that a big bonus did not involve a speedy decrease of the standard cost. Moreover, standard costs were determined for such small products that individual exertion carried its own reward in most cases. The rate of dividend was from two to twelve per cent. on the wages, while at the same time the cost of production was proportionately decreased, for the half of the gain went to the employers, and the turn-out was greater, while establishment charges remained constant.

"It will be at once apparent that the plan is limited in its application practically to standard productions,—almost to such work as is repeated indefinitely with few alterations. Where the product is a specialty, and a man or boy is kept at one machine turning out, say, bolts or studs, it is easy to determine the standard price. But even the Yale and Towne Company, enthusiastic as they were at one time, were forced to replace the system with a well-organized piece-work system, because, the groups restricted even to twenty, the want of uniform individual effort defeated the object. The chief reason, however, was that the products were of such infinitely varied character that it was found better to have a system where each man was directly interested in his work. 'The men seem better satisfied with the piecework system,' and the company got 'decidedly' better results than under the gain-sharing system. To quote again from Mr. Towne, 'the cost of articles has been greatly reduced; but it must be stated that this is probably due to the fact that piecework has taken the place of day work, and that the dropping of gain-sharing has made but little difference one way or the other.' The point is that piecework is more effective and more acceptable to the men than gain-sharing."

A number of other examples, illustrating the argument, are adduced, and the able editorial concludes with an unanswerable argument in favor of a well-devised piecework system, whenever the nature of the work admits of its practical application.

"A piecework system, to be fair, should be reasonably liberal, and, where possible, rates should be permanent over a period of years. No more effective cause of discontent can be suggested than the reduction of piecework rates as a sequence to the earning of big wages. This is often practised by the over-zealous foreman, sometimes without the knowledge of the employer, although we fear at other times with his tacit approval. This especially so with squad piecework, and it has resulted in extraordinary effort being required for little more than 'time and quarter' wage. We are satisfied that in ordinary cases, where a fair contract rate is offered as the equivalent to the standard cost, pieceworkers will attain for employers the same degree of efficiency as with any gain-sharing scheme. Careless work but indicates too often the lessening of rates of remuneration. And, as for the drones in the hive, the pieceworker will as quickly get rid of him as did the good-fellowship worker at the Thames Iron Works, where three hundred or four hundred were discharged in a few months at the request of 'the fellowships.' Moreover, there is no great objection to the drones ultimately uniting together as a squad. The other advantage of profit-sharing in the direction of ingenuity can easily be covered by awards for inventions,—an arrangement which readily appeals directly to most men,—while the detection of flagrant waste of material is the duty of the foreman. Like the workman, he need have no special incentive to duty, although the steady growing practice of presenting a *douceur* at the end of the year, which may or not be in proportion to the year's profit, is commendable and a special incentive. But, for this *douceur*, let there be no nibbling at piecework contract prices."

The impracticability of the system as a general panacea for industrial woes, unless human nature be changed, is apparent.

Cotton Mills in the Southern States.

INDICATIONS of a growing fear that British commercial supremacy is threatened by American enterprise are multiplying in the English technical and trade journals. One of the latest is an article in *Machinery* (London, Nov. 15) by a writer who seems to have studied the rapid development of the cotton industry in the southern States, and to realize its full significance. His article is interesting as exhibiting the conclusions reached by an intelligent Englishman in a tour of observation among the southern cotton mills, as containing some rather highly-colored statements relating to the conduct and management of these mills, and as giving a very fair view of the peculiar social conditions that favor the extension of the cotton industry in the south.

The observations of this tourist appear to have been chiefly confined to North and South Carolina, Virginia, and Georgia, which are fast coming to the front as cotton-manufacturing States, — Massachusetts, however, still retaining the lead. He says:

"Scores of mills in the north have had to change over to medium and finer counts because of the far lower cost of production in the States named compared with the northern and eastern States of America. The south has beaten them out of the market on nearly all grades of brown and colored (heavy goods), such as sheeting, drills, shirtings, domestics, duck, demins, plaids, cottonades, tickings, plain ginghams, 2-, 3-, and 4-box ginghams of two or more harness (heald) work. And at the present time there are more than two hundred mills throughout the south running successfully and reaping the finest dividends in the world (some declare ten to thirty per cent. per year), besides large surpluses for additions, machinery, etc., and sinking fund. Besides supplying the home markets with considerable quantities of goods, they also do a magnificent trade with China, Central and South America, Mexico, and Japan, and they also ship checks, plaids, drills, and plain ginghams to France and Dutch countries, and one of the largest mills of the south, the John King Manufacturing Co., of Augusta, Georgia, sends cloth directly to Manchester, right into our own markets, if you please. The writer was with a large mill of this kind, and *Machinery* readers will please cast all prejudices at one side when reading the facts and figures, which are given for the benefit of mill men. In one large mill in South Carolina, where brown goods of coarse counts and light pick and reed are manufactured, the cost of production per pound throughout the different parts of the mill are as follows:

"Cost of production per pound: carding, 0.35 cents; ring-spinning, 0.36 cents; warping, winding, and slashing, 0.28 cents; weaving, 0.93 cents; a total of 1.82 cents. This includes labor and room management only, exclusive of other expenses.

"The management of the mills receive large salaries, but deserve every dollar they get. It varies from four to ten dollars per day for weaving department managers, and those controlling other departments get from three to six dollars, according to locality, size of mill, and quality of goods, etc. The superintendent receives from three thousand to six thousand dollars yearly, besides other income which those gentlemen keep quiet about. The help are mostly natives, and first-class workers they are under conditions of temperature they must work in.

"The general average of earnings is seventy cents per hand per day, and they are satisfied with whatever they receive. In the cities they pay more than in the country. In fact, some places do not pay out anything, and paper is discounted at the corporation's store in the village for its face value. The only reason that can be given for hands working year out and year in for such remuneration is their strong attachment to the locality where they were born and raised.

"Working hours are sixty-six to seventy-two per week, and machinery is kept at full speed. Two or three score mills are running five nights per week, with two forces of help. The country is magnificent, and there is water power all over the south in abundance, and it can be bought at a reasonable figure, and land is given away to manufacturers for building purposes. Several cities own splendid water powers, which are very powerful all the year around, and are rented out very cheaply. The city of Augusta, Georgia, rents its power at $5.50 per horse-power per annum, and takes all responsibility of repairs. The city is supplied by the Savannah river. Water power on Cataoochee river is leased for $4.20 per horse-power per annum."

We are not responsible in this review for this writer's exaggerations and misconceptions. Southern labor is highly spoken of. It is claimed that it produces "as much as any northern or imported help in the east," and asserted that it would undoubtedly produce more, if artificial means were supplied to cool the temperature in mills during the summer months. The quality as well as the quantity is surprising to our English tourist.

"Many men and women weavers produced 88 per cent. of the speed of the loom on heavy ducking, where change of shuttles is very frequent, and looms ran at a speed of 175 picks per minute (45 in. reed space). Each weaver minds seven looms. The loom fixers (tacklers) do not attend a loom until the red flag is put up. Each weaver is supplied with a red flag, and is ordered to stick it on the loom whenever they want the fixer, and they must leave it up until that man should attend. If it remain up too long, the overseer or assistant wants to know the reason why, and 'wrangling' or hard looks between fixer and weaver in that country are not seen. If there were either, one or both would be laid in 6 ft. by 2 ft., in short order, as 'dead as a door-nail.'"

The following statement is quoted as one of those amusing misconceptions which foreigners sometimes acquire during a rapid tour in America.

"All overseers and superintendents, and most help, carry revolvers and knives continually. Some of them conceal the weapons, and some of them are quite open for everybody's inspection. And neither manager nor employee (whether man or woman) will listen to the least insult, nor stand any fooling, but will resent it by force. It is a novel sight to go into some southern mills where firearms are carried. This must not be taken to mean that southerners are desperadoes and criminals,—not at all. They are the most civil-spoken (they have to be) race. An English manager who would try in the south to manage a mill on the same plan as in Lancashire would receive two hours' notice to quit, and his life would not be worth a cotton-seed if he refused to comply.

"Cheap cotton, cheap labor, and cheap coal; low price of water power; freedom from taxation from ten to fifteen years for new concerns; fair transportation rates, etc.,—are the chief elements which enable the southern manufacturer to compete with any other part of the world. This is no experiment, for there are seventy new mills in construction and starting up at present; and there is native help for one hundred more, and the people can be taught very quickly, and become splendid workers. Living is cheap, and everybody grows his own vegetables. Some operatives use oil or gas stoves for cooking and little fuel is used. No underclothing is requisite, and a few dollars completes an outfit."

An Important Lesson.

ONE important lesson, says the Progress of the World for January, which the December panic and recovery must have taught the international banker (and it is one which may stand this country in good stead on some future occasion) is that the National policy of the United States is not capable of being controlled by pocketbook losses. It is also apparent that no premeditated policy, directed against Wall Street values, would suffice to induce us to recede from what we considered to be a righteous position. We have demonstrated our self-reliance, too, in a most striking manner. The banks of New York, as soon as practicable after the blow had fallen on securities at the Stock Exchange, decided, by the authorization of the issue of Clearing House loan certificates, to virtually consolidate all their resources, the strong upholding the weak, and thereby to assure the prevention of default or insolvency on the part of any merchant or brokerage house whose assets were ample, but who might not, amid the cycle of panic, be able to liquidate them to advantage. The promptness of this action was at once effective in allaying financial alarm, and even in the face of a hesitating and still nervous London market, our home securities rallied promptly almost to the basis from which the precipitate decline began.

There is ground for hope that the influence of the United States as a new political factor in the possibilities of international finance may work in the interests of peace and stability. On the surface, the danger of sudden war alarms in which this country may be concerned may not seem to promise much in these directions. But is it not reasonable to suppose that the directors of the financial world in Europe —the great bankers of London, Paris and Berlin—will be more observant hereafter of the course of European diplomacy concerning matters in which the United States are interested, and may on occasions lay cooling hands on the feverish pulse of some foreign "Jingo" statesman ?

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*3003. Jingoism, or War upon Domestic Industry. Edward Atkinson (Showing the effect of an aggressive foreign policy upon industry and commerce, and proposing an international union for the maintenance of justice between nations). Eng Mag–Feb. 4500 w.

*3010. Our Commerce with Latin America. Emilio M. Amores (Reviewing the natural resources of Latin American countries and the conditions upon which the United States can secure an increased share of the commerce therewith). Eng Mag–Feb. 4700 w.

†3016. Physics and Sociology. W. H. Mallock (The first part is a dissertation on the application to social phenomena of the methods and principles derived from physical science, and on the crucial difference between the subject-matter of physical science and that of social science, which render the methods of study proper to the first inadequate when applied to the second). Contemporary Rev–Dec. Serial. 1st part. 13000 w.

†3049. Interstate Tariffs in Mexico (Advance sheets of Consular Reports). Dec. 2300 w.

†3117. England in Nicaragua and Venezuela. G. H. D. Gossip (A consideration of the subject from an American point of view). Fortnightly Rev–Dec. 6500 w.

†3168. Rural Loan Associations in Germany. H. F. Merritt (Origin, development, and effects of mutual benefit associations in Germany). Advance sheets of Consular Reports. Dec. 3300 w.

†3169. Agrarian Movement in Germany. Charles de Kay (Particulars of a growing organization in Germany and its present resources; its purpose being to establish banks and by advancing money on crops to rescue the farmers from middlemen, alleged to be preying upon them. It also has the character of a political party). Advance sheets of Consular Reports. Dec. 1500 w.

3222. Analysis of Ten Months Foreign Trade (Review of the detailed statement of the Bureau of Statistics). Bradstreet's–Dec. 21. 900 w.

3231.—$1. The Theory of Social Forces. Simon N. Patten (An attempt to recast current social philosophy and to introduce into it elements which thus far have been overlooked. It considers the influence of the environment; race psychology ; knowledge and belief ; a social commonwealth ; and normal progress). An of Am Acad–Jan. 150 pgs.

3232.—$1. The Nicaragua Canal and the Monroe Doctrine. L. M. Keasbey (An outline of the issue between England and America in the case of the Nicaragua Canal Route. An interesting historical review). An Am Acad–Jan. 11500 w.

3234 —$1. The Nicaragua Canal and the Economic Development of the United States. E. R. Johnson (The writer believes that the future industrial and commercial development of the country is largely conditioned upon the early construction of this canal. He gives a brief outline of the influences it will exert, showing that the benefits will be shared by all parts of the country). An Am Acad–Jan. 4000 w

*3244. Money in Legislation. Sidney Sherwood (A review of the present monetary situation and its causes). Chau–Jan. 4000 w.

*3258. Trade and Industry of New Caledonia and Tahiti (Descriptive of the people and their work ; the facility with which the white man becomes acclimatized ; the resources, &c). Bd of Tr Jour–Dec. 1800 w.

*3259. The Competition of the Industries of Japan with Imports from Europe (The productive capabilities of Japan are briefly discussed with special reference to their influence on German export trade). Bd of Tr Jour–Dec. 900 w.

*3260. Tariff Changes and Customs Regulations (Russia, France, Portugal, Spain, Bulgaria, Turkey, United States, San Salvador, British India, Cape Colony). Bd of Tr Jour–Dec. 4600 w.

*3296. Some Suggestions on Currency and Banking. Adolf Ladenburg (A brief review of the currency question, and suggesting as a remedy for existing evils, the development of our clearing-house system). Forum–Jan. 2200 w.

*3297. Railroad-Rate Wars; Their Cause and Cure. John W. Midgely (A statement of the conditions out of which present evils have grown, with suggestions of the remedy). Forum–Jan. 5000 w.

3343. Mercantile Failures for 1895 (Tables of embarrassments and failures for the year, with assets and liabilities, arranged by states). Bradstreet's-Dec. 28. 1200 w.

3344. Great Britain's Declining Colonial Trade (Editorial on the dislodgment of British colonial trade, by Germany, France, Belgium and the United States). Bradstreet's-Dec. 28. 1200 w.

†3373. Both Sides of Profit-Sharing. Frederic G. Mather (The system discussed and many examples cited where the benefits have been mutual, but concluding that neither profit-sharing nor any other device will improve the situation, if there is lack of sympathy on either side toward the other). Pop Sci M–Jan. 2500 w.

*3375. The Law of Demand in Work. William B. Chisholm (An essay on the dignity of labor and its beneficial effects). Am Mag of Civ-Jan. 2700 w.

*3376. Reality vs. Romance in Economics. T. E. Willson (An effort to show that the idea that the United States is a debtor nation is erroneous). Am Mag of Civ-Jan. 2200 w.

*3377. The Ethics of Commerce. Allen Ripley Foote (Showing that commerce cannot thrive where man's natural rights are not recognized. Giving examples of various forms of injustice, dishonesty and fraud and their effects). Am Mag of Civ–Jan. 1500 w.

*3378. Indian vs. American Cotton-Mill Operatives. J. W. Bennett (A brief account of the very cheap labor in the mills of India, and the simple way of living, in contrast with that practiced by workers in the same field in America). Am Mag of Civ–Jan. 800 w.

*3379. Practical Bimetallism and Ideal Protection. Frank Rosewater (The conclusion reached is that genuine exchange can be possible only on the basis of a uniform standard of values A new system is proposed with reasons. The writer thinks that if affairs are guided with reason, an unprecedented period of prosperity is before the country). Am Mag of Civ–Jan. 6000 w.

*3380. Sociology and Criminology. Clark Bell (From advance sheets of the *Medico Legal Journal*. The study of the criminal instead of the crime). Am Mag of Civ-Jan. 900 w.

*3471. Experience with Profit-Sharing (An able editorial reviewing principally American experiments in this line, and pointing out the limitations which restrict its application, these being found both in the nature of trade and in human nature. The piece-work system is considered preferable). Engng–Dec. 27. 4500 w.

*3493. Representative Women on the Vital Social Problems. I. Henry George and Nehemiah. Celia Baldwin Whitehead. II. How the Single Tax Will Free Men. Estella Bachman Brokaw. III. Notes in Reply. Frances E. Russell (Those who wish to study the workings of the feminine intellect, in discussing great public questions of political economy, will find an interesting opportunity in this symposium). Arena–Jan. 6500 w.

*3494. Should the Government Control the Telegraph? (A continuation of the symposium on this subject). I. Postal Telegraph. Lyman Abbott. II. Why I Oppose Governmental Control of the Telegraph. William L. Wilson. III. Why the Government Should Control the Telegraph. Frank Parsons (Dr. Abbott advocates the scheme and gives his view of the advantages of the plan. Postmaster-General Wilson follows with a strong argument against the scheme, holding that it could only be operated at a yearly loss, and also questioning its general feasibility under our political system. Prof. Frank Parsons takes sides with the advocates of the scheme, taking the radical ground that it is a question of the people vs. monopoly). Arena–Jan. 7000 w.

*3495. The Bond and the Dollar. John Clark Ridpath (A remarkable essay. The startling statement is made that the national debt of the United States, in its bonded and unbonded forms, will purchase as its equivalent in value as much of the average of twenty-five of the leading commodities of the American market, including real estate and labor, as the same debt would purchase at its maximum on the 1st of March, 1866. The people have paid and paid for thirty years, and at the end have paid just this—NOTHING! A formidable array of statistics is presented to sustain this statement. The article is in the nature of a general protest against the method of raising money for governmental purposes by bond issues). Arena–Jan. Serial. 1st part. 4800 w.

*3518. The Progress of Banking in Great Britain and Ireland during 1895 (Exhaustive survey of the present status of banking operations, with copious statistics. The conclusion arrived at is, that after the previous years of financial disturbance, the banks of the United Kingdom are tending to resume their normal condition). Banker's Mag–Jan. 6500 w.

*3519. The United States Gold Problem. W. R. Lawson (A criticism of Pres. Cleveland's financial policy, being specially severe upon his attitude toward the greenbacks, claimed to be the only sound currency in the Union. The banking system of the United States is also severely criticised, but it is deemed to have taken too firm a hold on the people to admit of any hope of disestablishment). Banker's Mag–Jan. 6000 w.

*3520. Monetary Review for the Year 1895 (Market features of the year; trade in 1895; eastern and foreign exchanges; politics; banking, etc). Banker's Mag–Jan. 3300 w.

MARINE ENGINEERING

Water-Tube Boilers in Marine Service.

In this department for January we printed a review of a paper entitled "Tubulous Boilers in the French Navy." The paper was prepared by Assistant Engineer Robison, of the United States navy, and published in the *Journal of American Society of Naval Engineers*. It purported to give conclusions derived from personal observations; and from the character of these conclusions, and the reputation of its author, it has attracted an unusual amount of attention.

In *Engineering* (Dec. 13) Messrs. Maudsley, Sons and Field, manufacturers of the Belleville boiler in England, who have placed it on a number of British warships and some merchant vessels, take exceptions to Mr. Robison's paper in general, and to his statement regarding the Belleville boiler in particular, and subject the paper to criticism so severe that probably it will call out a rejoinder. In this review we shall attempt to give only a summary of the first part of the communication of Messrs. Maudsley, Sons and Field, which occupies over four closely-printed columns in *Engineering*.

They assert that Chief Engineer Robison's paper needs explanation in some parts, and contradiction in others, thus raising questions of fact calculated to throw discredit upon the accuracy of the author's observations.

To the statement that automatic feed-regulators have been made necessary by the adoption of the Belleville boiler in the French navy, they reply that such regulators are not now unusual, and predict that they will before long become common on the higher-class steamers. The objection that they were once sources of danger through incrustation of floats and working parts no longer holds against them, since filters and evaporators have become efficient aids in purifying water.

The statement that tubes deteriorate through imperfect circulation is characterized as "untrue." The Ortegal, a vessel in continual service for ten years, is cited as an example, the tubes having given no unusual trouble during that period.

The correctness of the statement, as to priming, that the steam contains ten per cent. of water is also denied, and it is alleged, on the contrary, that water is carried over only on starting the engines, and that, thereafter, as shown by the French experiments, the steam is superheated.

As to economy, the statement is made that the evaporative efficiency of the Belleville boiler is higher than that of the single ended boiler when worked under precisely the same conditions. This is affirmed to have been the case in a majority of trials, which, moreover, have indicated superiority in this respect over the double-ended boiler.

It is denied that the feed-pumps, as compared with other pumps of a similar class, require an undue amount of steam to drive them, as was asserted.

The statement that "the accessories of the boiler are so numerous that they make a considerable addition to the machinery of a vessel" is declared to be a misrepresentation, as is also the statement that "the repairs to the boilers are more costly than those for ordinary boilers." The superintending engineer of the Messageries Maritimes Company is quoted as stating that the repairs to Belleville boilers on the ships of the company are from two to three per cent. less than those required by their cylindrical boilers.

The statement that ships fitted with Belleville boilers "have more boilers than are necessary to the running of the engines at full power" is also pronounced a misstatement. This error might have grown out of the fact that, while the "Messageries Maritimes steamers were built for 17½-knot speed, their mail-contract calls for an average passage of only 15 knots. Hence they have an excess of boiler power for the required speed, but not for their designed speed. This criticism is unfair.

That the D'Allest boilers are lighter than the Belleville boilers is also denied. It is asserted that, "counting water to the same level with steam pressure up to one hundred and eighty pounds per square inch," these boilers are practically of the same weight; beyond that, the weight is in favor of the Belleville.

The allegation that it is more practicable to force the D'Allest boilers than the Belleville is also denied. The French government does not require a greater consumption of coal per square foot of grate of the D'Allest boiler than is demanded of the Belleville.

The manufacturers, while stating that salt water can be, and has been, used "for considerable periods" without deteriorating the boilers or causing trouble from scale, do not, as implied by Chief Engineer Robison, think it the proper thing to use salt water in them.

It was alleged that the D'Allest boilers could be worked without automatic feed-regulators. Mr. Robison's critics allege that neither the D'Allest or any other water-tube boilers can be worked at sea "without automatic feeds, unless extraordinary pains and trouble be taken by those in attendance," and that these appliances are now being fitted both to water-tank and water-tube boilers in warships.

Mr. Robison's statement that, "while the D'Allest boilers use more coal than Scotch boilers for similar engines, ... the loss in coal has been with the Belleville boilers as much as forty-two per cent.," is stated to be "absolutely untrue." On the contrary, as good results in fuel consumption are claimed for the one as for the other.

The statement that reducing valves are required between any kind of tubulous boilers and the engine by the French government is admitted. It is explained that this is done solely to maintain steady pressure at the engines.

The conclusion expressed by Mr. Robison with reference to the Niclausse boiler is questioned on the ground of insufficient data. "The Friant is the only ship fitted with Niclausse boilers, and she has been in commission only six months," a period deemed too short to afford a basis of comparison of the relative cost of repairs.

As to the economy of the D'Allest boilers, it is asserted that this has not been the main reason for their adoption in France. The reasons are alleged to be of a commercial character, and not derived from a conviction of the engineering superiority of the D'Allest boilers.

The Serve tubes in the rows next the fire, instead of having been adopted on account of their greater durability, were tried, it is said, in the Belleville boilers without securing any appreciable advantage, and it is intimated that they were perforce adopted in the D'Allest boilers, because ordinary tubes next the fire would not stand the extreme heat.

Passing without remark what is said of the Belleville, D'Allest, and Niclausse boilers, as merely a matter of personal opinion between disputants, we come to still another denial of a statement by Mr. Robison, who said, in substance, that, while the Messageries Maritimes Company (one of the greatest of the French steamship lines) appeared to be fairly well satisfied with the performance of the Belleville boiler, it was still seeking for something more economical. He also asserted that for the last vessel designed for the company (the Ernest Simon) designs for Scotch boilers were prepared, and that, when he left France, there was still a question as to which type of boiler would be adopted.

This statement is pronounced grossly inaccurate, and it certainly appears that Chief Engineer Robison was misinformed in making it. The Ernest Simon was fitted with Belleville boilers, and has been some time in service. Since the first ship in which the company placed these boilers was fitted with them, sixty thousand horse power of the same boilers have been fitted in their ships, including those now going into the large mail steamers,—Chili, Peru, Cordhilera, and others. The Ortegal, not the Australien (as named by Mr. Robison), was the first ship of this great company supplied with the Belleville boilers.

The boilers are ten rows high, instead of twelve rows as asserted. It is denied that feed water has "ever been admitted at the lower part of the boilers,"—even on the Australien, as Mr. Robison said *he has seen it*. It is denied that tubes break from water-hammering. Mr. Robison's assertion that the doors of a tube nest are never opened except to clean tubes is cited as proof that "*he never made a voyage in a vessel fitted with Belleville boilers*," or that, if he did, "*he never watched the management of the stoke-holds*."

In conclusion, it is charged that, with reference to the care and attention required, Mr. Robison has added exaggeration to his inaccuracy of statement. Thus this critique amounts to a general denial of facts alleged by Mr. Robison, and throws discredit both upon his ability as an observer and upon the impartiality of his conclusions.

The Coming Exhibition at Kiel.

FOLLOWING the great celebration of the opening of the North Sea Baltic canal of last year at Kiel, there will be this year—May to September inclusive—a unique naval and fishery exhibition. The enterprise is a private one, but *Engineering* (Dec. 6) asserts very positively that direct money-making is not its object. The main purposes are to present to the world the present importance of Kiel as a maritime center, further development of trade, and a demonstration to the world of the German advances in marine engineering.

There are to be three groups of exhibits, two of which are of special importance and interest to marine engineers, to wit: (A) navigation on the sea; (B) navigation on rivers; (C) fishery.

The groups and the classes in each are as follows:

A.—Navigation on the Sea.

Class I.—Sea and coasting sailing vessels,—models and drawings of modern and historical types.

Class II.—Paddle and screw steamers,—models and drawings.

Class III.—Motor boats of every description,—models and drawings.

Class IV.—Race cutters, sailing yachts, &c.,—models and drawings.

Class V.—Equipments for vessels of every description, such as masts, sails, rigging, anchors, chains, &c.

Class VI.—Engines, boilers, and fittings,—models and drawings. Furnaces, fireboxes, feed-pumps, feed-heaters, &c.

Class VII.—Construction of vessels,—models and drawings. Arrangement of engines with regard to vibration. Water-tight compartments.

Class VIII.—Propellers,—models and drawings. Paddle wheels, screws, and other systems. Propelling by direct action of water, &c.

Class IX.—Coal and other fuels.

Class X.—Nautical instruments,—compasses, sextants, steering apparatus, alarm signals, sirens, ship lanterns, and electrical installations of all descriptions.

Class XI.—Lighthouses, lifeboats, saving of wrecked vessels, &c.

Class XII.—Food and food-preparing appliances, baking ovens, filter apparatus for drinking water, conserves of meat, ice machines, kitchens, &c.

Class XIII.—Cabin and saloon fittings, bedding, hammocks, lights, ventilators, refrigerators, &c.

Class XIV.—Equipment of the crew. Clothing, pantry, weapons, &c.

Class XV.—Naval hygiene,—ventilation, heating, pharmacy, surgery.

Class XVI.—Installations for maneuvering sails, for charging and discharging cargo,—cranes, winches, installations for coaling on sea.

Class XVII.—Materials used in ship construction,—wood, iron, steel, tinplate, armor-plate, copper, hemp, linen, cotton, canvas, rope, paint, &c.

Class XVIII.—Marine literature, marine paintings, charts, statistics; results of scientific naval research. Meteorological observations.

B.—Navigation on Rivers, &c.

Class XIX.—River steamers, tugs, ferry-boats, ice-breakers, appliances and vessels for raising wrecks,—models and drawings. Warehouse installations for charging and discharging cargo, &c.

Class XX.—Models and drawings of harbors, wharves, docks, pontoons, etc.

C.—Fishery.

Class XXI.—Sailing vessels and steamers for sea-fishing,—models and drawings.

Class XXII.—Equipment, outfit, apparatus, and implements for whale and seal fishing, and for miscellaneous fishing.

Class XXIII.—Coast fisheries,—vessels, equipments, nets, and other apparatus for fishing.

Class XXIV.—River and lake fishing and appliances.

Class XXV.—Salted and preserved fishes for food, utilization of fish residues.

Class XXVI.—Fishing huts, dresses, and equipment.

German Shipbuilding.

ONE of the effects of the present strained relations between leading nations is the impetus given to naval construction. As never before, it has been impressed upon the minds of men that the most powerful navies are destined to shape future history, and every nation of importance is making an effort commensurate with its means to enlarge its navy to formidable proportions.

Thus, during the past year, the building of war-ships has had an unprecedented share in marine construction, and, while the number of vessels of this kind is multiplying, their cost is also constantly growing under the effort to increase their efficiency. Germany is a nation in which this tendency is particularly noticeable. *The Steamship* (English) for January says:

"Germany is following with extraordinary interest the present crisis in British shipbuilding, and has already profited to a considerable extent by it. It seems determined, at any cost, to develop its shipbuilding industry to the utmost extent. The committee of German iron and steel works recently held a meeting at Hanover, and they have drawn up resolutions asking the government to make reductions in railway freights for all shipbuilding material used in German shipbuilding yards, and also to make it compulsory that all material used in ships of war shall be of German manufacture.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*3030. The "Evoy Jumper-Stay" Compass. Ill. (Describes a new ship's compass, so rigged that it can be hoisted aloft out of reach of local influences, the needle locked in that position, and the compass lowered to the deck again for reading). Marine Eng-Dec. 1. 600 w.

†3042. Plan of the Madras Harbor (Full-page drawing, with explanatory note). Ind Engng-Nov. 9. 300 w.

*3048. The Performances of Ocean Steamships. Arthur J. Maginnis (Suggests and advocates the estimation of steamship performance from the single basis of coal consumption. The unit basis being 1 lb.). Steamship - Dec. 2500 w.

3065.—$1.25. Contract Trial of the United States Coast Line Battle Ship Indiana. Harry Hall (Full description of the machinery and tests, with infolding plates and tabulated results). Jour Am Soc of Nav Eng-Nov. 6500 w.

3066.—$1.25. The Steam-Yacht Yosemite. B. F. Isherwood (Tabulated data and results from notes and indicator diagrams taken during a trial of four consecutive runs, with tables of dimensions and description of machinery). Jour Am Soc of Nav Eng-Nov. 6500 w.

3067.—$1.25. Test of a Babcock and Wilcox Boiler to Determine its Evaporative Efficiency (Descriptions and tabulated results of test made under instructions from the bureau of steam engineering of the U. S. Navy Department, with plates showing construction of the boiler and arrangement of the same in the Plant steamer). Jour Am Soc of Nav Eng-Nov. 4200 w.

3068.—$1.25. Torpedo Boat Destroyers. John Isaac Thornycroft and Sydney Walker Barnaby (Reprinted from Pro. of Inst. of Civ. Eng. Paper both historical and technical, with plates). Jour Am Soc of Nav Eng-Nov. 9300 w.

3069—$1.25. Experiments to Determine the Causes of Steam Pipe Explosions on Board German Naval Vessels. Translated by William Wachsmann (Full account of preparations for and manner of conducting the tests, with plates, results and conclusions. A valuable paper). Jour Am Soc of Nav Eng-Nov. 2300 w.

3070—$1.25. Liquid Fuel for Naval Purposes. John R. Edwards (One of a series of lectures delivered at the Naval War College, Newport, R. I. A strong argument setting forth the great advantages of liquid fuel for marine use, and containing suggestions looking toward safety and efficiency in its application to this purpose). Jour Am Soc of Nav Eng-Nov. 7600 w.

3071.—$1.25. Trials of the Lake Steamships Zenith City and Victory. B. C. Bryan (Dimensions and account of test trials, with tabulated results). Jour Am Soc of Nav Eng-Nov. 4000 w.

3072.—$1.25. Ships (Dimensional data, etc., of ships of the United States and other countries). Jour Am Soc of Nav Eng - Nov.

We supply copies of these articles. See introductory.

13500 w.

3073 —$1.25. Merchant Steamers (Dimensional data, etc., of recent American and foreign merchant vessels). Jour Am Soc of Nav Eng–Nov. 3500 w.

3074.—$1.25. Yachts (Brief descriptions of recently built yachts). Jour Am Soc of Nav Eng–Nov. 1100 w.

*3100. The Torpedo-Boat Destroyer "Lightning" after Collision with a Barge. (Description, with illustrations, of damage to this boat caused by her collision with a barge). Engng–Dec. 6. 1100 w.

*3102. The Kiel Exhibition of 1896 (Gives a programme of this exhibition which will comprise exhibits in three groups—navigation on the sea, navigation on rivers, and fishery. The first of these groups contains eighteen classes of marine engineering exhibits; the second comprises two classes, and the third seven classes. The whole will form an unique exhibition). Engng–Dec. 6. 1200 w.

3152. The Fight of the U. S. Naval Engineer Corps (An editorial argument favoring the increase of authority of engineers in the U. S. Navy to a point commensurate with their responsibility). Am Mach–Dec. 19. 1000 w.

3166. Collisions Between Steamers and Whales. Ill. (A résumé of the occurrences of this kind which were on record prior to the collision of a steamer and whale, recently noticed in the daily and weekly press). Sci Am Sup–Dec. 21. 600 w.

*3194. The United States Cruiser "Minneapolis" (Illustrated description and contract trial data of this new cruiser. The official trial took place July 14, 1894). Engng–Dec. 13. 2000 w.

*3195. Shallow Draught Steamer for Russian War Service (Illustrated detailed description of a steamer, designed specially for service in shallow water on the Amu Darya River, and of which the official trials gave very satisfactory results). Engng–Dec. 13. 1200 w.

*3198. Water-Tube Boilers. Maudslay, Sons and Field (Review and criticism of a paper written by Asst. Eng. Robison, of the U. S. Navy, and published in the *Journal of the Am. Soc. of Naval Engs.* The paper purported to give results from personal observations in France, which results are disputed in this review, and the paper, as a whole, is severely criticised). Engng–Dec. 13. 4300 w.

*3204. The Thames Iron Works and Shipbuilding Company (A very complete illustrated and detailed description of one of the largest and most important shipbuilding and marine engineering works in the world). Eng, Lond–Dec. 13. 11000 w.

3267. Our Merchant Marine (The American shipping is characterized as our one bankrupt industry, but "protection" is alleged not to be the cause, the contrary is affirmed, and an argument favoring discriminating duties and taxes follows. This policy is advocated in full view of its enormous difficulties, among which the fact that no less than thirty-five treaties would have to be abrogated or modified is not the least obstacle). Sea–Dec. 26. 3800 w.

*3349. Hepburn and Stewart's Patent System of Plating (General illustrated description of a new system, for which many advantages are claimed). Eng's Gaz–Dec. 350 w.

*3350. Broken Eccentric Strap (An interesting narrative illustrating the danger of makeshifts, the pig-headedness of a ship's captain, the stupidity of a chief engineer, and the sagacity of a second engineer). Eng's Gaz–Dec. 500 w.

*3351. Machinery Rules (Editorial upon the divergencies in the requirements of the various bodies which approve engines and boilers for ships, and a review of a paper recently read by Mr. John Key, at a meeting of the British Assn. at Ipswich, in which a uniform factor of safety for boilers and machinery for ships is advocated). Eng's Gaz–Dec. 700 w.

†3364. War and Its Modern Instruments (A symposium in which William S. Aldrich treats of "Speed in American War-Ships." P. H. Colomb Discusses the "Test and Value of Speed in War-Ships"; S. B. Luce Discourses on "Naval Warfare Under Modern Conditions," and John K. Cree talks of "The Influence of the Air-Ship in War"). N Amer Rev–Jan. 14500 w.

3411. Submarine Boats. Ill. W. A. Dobson (An account of progress in submarine navigation from Bushnell's boat (1776) to the present). Cos–Jan. 3600 w.

*3447. The Year's Shipbuilding (An interesting retrospect of this industry during 1895, incidentally touching upon the advantages and disadvantages of water-tube boilers—questions that have been hotly debated during the last twelve months). Ind & Ir–Dec. 27. 3500 w.

*3474. Shipbuilding and Marine Engineering in 1895 (A summary of the industry for the year and a review of the present status of the trade, from which the outlook is considered hopeful). Engng–Dec. 27. 3600 w.

*3499. Marine Engineering and Shipbuilding in the year 1895 in the United Kingdom (Review of the industry for the past year and a glance at the present status). Eng's Gaz–Jan. 8000 w.

*3500. An Investigation in the Forces Tending to Produce Vibration in High Speed Engines (Conditions of inertia including both rotary and reciprocating parts with and without balance weights, and independent of, as well as combined with, the effect of steam under usual working conditions, are considered in these investigations, and the data arrived at experimentally are systematically presented). Eng's Gaz–Jan. 700 w.

*3536. The Pendulum Propeller. Ill. H. C. Vogt (An able exposition of principles of propulsion as exemplified in fishes, and a mathematical discussion of those principles). Steamship–Jan. 3800 w.

*3537. Water Ballast for Steamers and Sailing Ships. M. W. Aisbitt (A history of ballasting is given, followed by a practical consideration of water ballasting as applied in modern marine engineering). Steamship–Jan. 2700 w.

MECHANICAL ENGINEERING

Ethics for Draftsmen.

MR. ARCHIBOLD DENNY, in his presidential address at the Institute of Junior Engineers this year, said that the engineering firm to which he belongs had found it expedient to formulate the following rule, quoted from their general order book :

"As there is growing in our office a large amount of special and organized information procured and organized at considerable expense by us, it must be clearly understood by every member of our staff that we consider this information private, and to be used only in our service. Any member of our staff found copying or removing any of this special organized information will be considered to have acted against honor, and will, on our coming to know of his action, be immediately, and without further warning, expelled from our offices. To such a person we will decline to give either reference or character. We consider that the opportunities afforded to the members of our staff in their ordinary work, and for private study by our library, are sufficient to enable them to acquire a knowledge of all methods of working, by means of which, should they leave our service for that of some other firm, or to start on their own account, they can collect and organize information for their employers or for themselves. There is, therefore, no excuse for their acting against honor in the way we have now forbidden."

In an editorial review of Mr. Denny's address (which covered many other topics) *Engineering* (Nov. 22) says of this rule that it "is well known that Messrs. Denny have an experimental tank, as at Torquay, aad the experiments there made result in valuable data which are exclusively their property, and are not obtainable in any other private establishment. Such data are costly, and cannot be arrived at without the use of their expensive plant. To copy such data is in the highest degree dishonorable; but, further, objection is very properly taken in practically all establishments to any drawings being copied, and in this latter respect draftsmen do not so readily appreciate the ethics of the case. In the first case, comparatively little work is regarded as special, in the sense that it is too costly or too recondite for an ordinary firm to obtain it for themselves. Again, work, when completed, cannot be kept secret, as is so often supposed. An engine, a ship, or a mill is put to work, and as soon becomes the object of study by competitors. Even indifferent observation readily enables a man to sum up all the special points, and ingenuity is quickened in the direction of improvement.

"But clearly it is beyond discussion that the copying of drawings, either in the draftsman's own time or in his employer's, is an act of theft, unless it is done by permission. No man is justified in taking even a sketch out of the works, but this condition does not necessarily preclude the making of private records. For days the draftsman's brains are concentrated on the solution of some problem, and he only arrives at the conclusion by aid of prolonged thought and much toil. The results are incorporated in his design, and for a time, at least, they are impressed on his memory. The latter, however, is often a treacherous guardian, and the only safe method is to supplement it by memoranda and sketches of greater or less completeness. It will be conceded, we think, by all employers that it is the duty of a draftsman to be always educating himself in that which concerns the department of work in which he is personally engaged. He must watch, as far as possible, the result of his designs, and take note of their good and bad qualities. This year's mistakes must serve as the foundation of next year's successes. But this can only be done efficiently if they are exactly defined, qualitatively and quantitatively.'

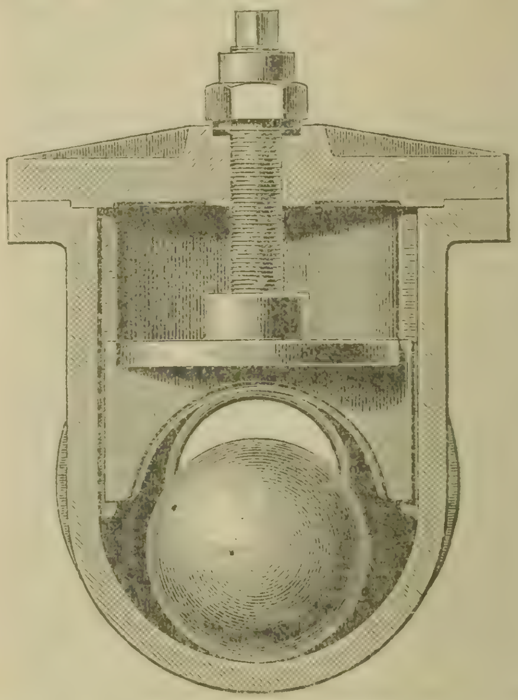
Now, to us it appears that the whole substance of a draftsman's duty in this particular is that he should take with him and consider as his property only that which he originates in his own time. There can be no wrong in a draftsman's taking away sketches of improved details invented or thus designed by him, or in his using them in future exigencies which he may meet; but, if set to delineate anything belonging to the firm employing him, that thing is not his, and he has no right to expose it to others or use it for his own or another's benefit. If a draftsman, after his day's work is over, sketches in his private room ideas which have occurred to him during the day, and which he wishes to retain as aids in future design, what right has his employer to either his ideas or his time? The fact is that employers are apt to assume the ideas of draftsmen to be their property, no matter how valuable they may be, and many a draftsman has been discharged for daring to make and patent an invention which, under threat of discharge, he would not assign to a covetous employer. It is difficult to draw hard and fast lines between honorable and dishonorable conduct. Circumstances and conscience must guide each man, and we much question either the need or the wisdom of such a rule as the one formulated by the Messrs. Denny.

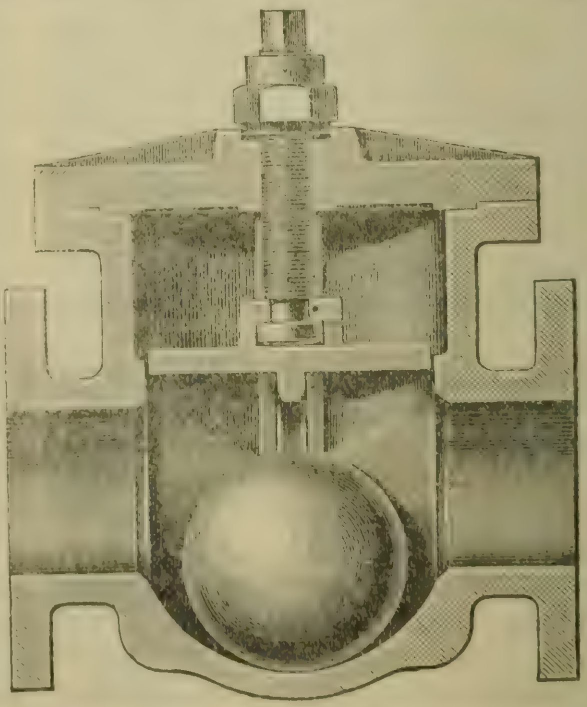
New Isolating Valve for Steam Pipes.

CURRENT events are emphasizing the need of a good isolating valve for steam pipes. Scarcely a month passes without the news of one or more men scalded to death by the bursting of pipes, and during December there were a number of fatal accidents from this cause. The most notable of these was on the steamship St. Paul. Another was in a New York theatre, and still another in a Brooklyn store.

The Practical Engineer (Dec. 6) described an isolating valve which has so much promise of efficiency that we have herewith reproduced the engravings, and made an abstract of the accompanying description.

When steam pipes burst, the greatest damage is generally done not so much by the explosion itself as by the immense volumes of steam and water which are poured forth by the broken pipe, threatening human life in the vicinity, the risk being aggravated where these accidents occur in confined situations. By careful supervision the risk of such accidents may be greatly minimized, but there are unavoidable cases where pipes may be subjected to strains which they were not originally calculated to stand, these strains being set up by bending, or caused by the expansion of the pipes by heat.



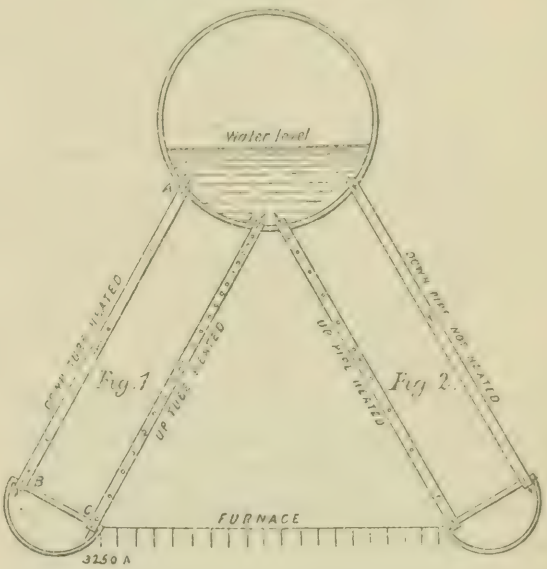


The valve shown is intended to automatically cut off steam communication from the boiler in case of such accidents. The valve contains a ball, which, in ordinary working, rests at the bottom of the casing. In the event of a pipe bursting, the sudden reduction of pressure on the outlet side of the valve will produce a rush of steam, which sweeps the ball along with it, and forces it against one or the other of the seatings provided for the ball at both outlets, enabling the valve to act either way.

The sensitiveness of the valve depends upon the area of the free passage past the ball, and an arrangement is provided for adjusting the area of this passage to allow the giving of any desired degree of sensitiveness to the valve. For this purpose a plate with a semi-circular opening, as shown in Fig. 2, is arranged across the passage in the center of the valve, and the distance between the ball and this plate can be regulated by turning the screwed spindle shown in the illustrations. The valve is proportioned so that in the highest position of this plate the ball would still close against the seating, in case of a complete fracture of the pipe.

This valve is accredited to Messrs. Schaffer and Bundenberg, well known to the engineering fraternity as the manufacturers of steam gages. The principle of the invention is sound, and, unless some practical difficulty comes in, it should be effective in closing off a steam pipe whenever the pressure is suddenly relieved by a rupture on the branch leading outward from the valve. To be of greatest service it ought to be placed as near the boiler as possible.

Circulation in Water-Tube Boilers.



SOME very interesting correspondence has recently appeared in *Engineering* (London) upon this important subject. Mr. Carlton L. Lambert, in a letter printed Dec. 6, supports a view previously expressed by Mr. Maxim, and says he has performed some experiments with U-tubes heated at the bend, and also heated on the down-legs of the tubes, the results of which he thinks amply prove that the heating of the down-leg gives even greater advantage than Mr. Maxim claimed for it. Assuming that both tubes are uniformly heated, and that the inner tube is heated twice as much as the outer one, he argues as follows: "In his explanation of the cause of these results Mr. Maxim does not go far enough, I think, if I interpret him rightly, and he understates the advantage derived from heating the down-tubes which can be deduced from his experiments. Mr. Maxim says: 'It will be seen that whatever retardation is caused by these bubbles in the tubes which are taken in the water downwards is exactly counterbalanced by the volume which they add to the steam in the pipes which are taking the water and the steam upwards.' Now, I venture to suggest that the retardation caused by the bubbles actually existing in the down-tube at any time is more than counterbalanced by the buoyancy of the bubbles continuously being delivered from the down-tube into the up-tube, and that, assuming each tube is to be heated equally along its length, the resulting circulating force is greater (by an amount equal to the buoyancy of the bubbles actually existing in the down-tube) than it would be if the down-tube were not heated. This apparent anomaly may be explained by the fact that the number of bubbles per cubic inch (which I will call the bubble density) increases uniformly from nothing at the top of the down-tube to its maximum at the bottom, and that, while the up-tube is being continuously fed with water of this maximum bubble density, the down-tube, as a whole, has an opposing buoyancy due to only half this maximum."

"Now, when both tubes are exposed, as shown in Fig. 1, the water, entering the down-tube at *A*, has no bubbles, but by the time it reaches the end, *B*, it has, say, 10 bubbles per cubic inch. Thus at *C*, the bottom of the up-tube, and through its entire length, there will be 10 bubbles per cubic inch, due to the bubbles coming from the down-tube; and at *D*, the top of this tube, there will be these 10 bubbles per cubic inch plus an additional 20 due to the heating of the up-tube, or a total bubble density of 30. Thus the mean bubble density in the up-tube is 20, whereas in the down-tube it is 5. This gives a difference of 15, which is the measure of the circulating force.

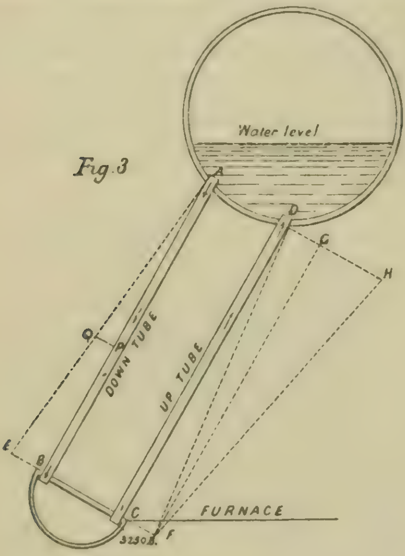


Fig 3

"Now, when the down-tube is not heated, as assumed in Fig. 2, there are no bubbles at all in the down-tube and none at the bottom of the up-tube, while there are 20 per cubic inch at the top. This gives a mean bubble density of 10 in the up-tube, and the circulating force, therefore, is only 10 in this case, compared with 15 when the outer tube is heated, showing a gain of 5 in favor of heating the down tube. Or again, we may represent it graphically (Fig. 3). Let us represent the bubble density at any point, say *P*, by a line *P Q* set up perpendicular to the tube. Then, if *E B* is the bubble density at the down-tube (both tubes being exposed to the fire), the area of the triangle, *AEB*, may represent the total buoyancy in the down-tube.

"Now, in the up-tube the set of bubbles which has been supplied by the down-tube will be represented by the rectangle, *CFGD*, where $CF = EB$; and the other set, actually generated in the up-tube, will be represented by the triangle *FHG*, where $HG =$ (say) twice *EB*.

"Thus the total bubble buoyancy in the down-tube is the triangle *FHD*. This is, therefore, the resulting circulating force, whereas, if the outer tube had not been heated, it would have been only the triangle *FHG*. Thus there is a distinct gain derived from the heating of the down-tube, which is measured by the triangle *FDG*. Now, *FDG* is the same as *AEB*. Thus the gain is exactly equal to the buoyancy of the bubbles actually existing in the heated down-tube." He thinks the effect in a large working boiler would be even greater than that shown in the laboratory experiment.

Per contra, Mr. William Cross thinks Mr. Maxim's opinion as to the *modus* of circulation in boiler tubes of this class will have to undergo some modification. To sustain his position he gives results of experiments made by him with a model boiler, an end view of which is given in Fig. 4. He writes: "This model was made with glass ends to the water drum, so that the circulation could be observed, and was

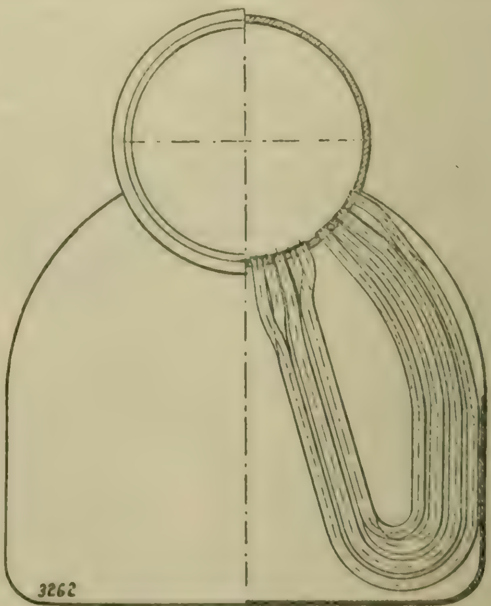


Fig. 4.

heated by two powerful Bunsen burners. With any reasonable amount of heat the circulation was perfect, a mingled torrent of steam and water foaming out of each upcast leg, while bits of 'flue,' which were purposely put into the water, could be seen being dragged into the downcast legs; but, when an undue amount of heat was applied (to do which the furnace was nearly filled with Bunsen burners), steam bubbles began to come up the downcast legs, and the rate of evaporation fell off, showing that the circulation was falling. In another experiment a full-size tube, having the legs only six inches apart, was fixed in a special furnace built for the purpose. When the furnace was forced to the very utmost, the same thing occurred, and the tube became white-hot, though both ends were under water. I would add that the amount of heat required to effect this was out of all reason, and could not conceivably occur in an actual boiler. But it would appear to show that Mr. Maxim's idea as to circulation may require some modification, and that by applying sufficient heat it is possible to stop circulation altogether; and, if this can occur in a U-shaped tube, why not in a Yarrow, which is practically the same thing, the bend of the U being replaced by the bottom water-pocket?"

A New Metal—Tempered Wrought Iron.

AN account in *The Railway Review* (Dec. 14) of a new metal discovered and just brought to notice by a Mr. Dawson of Des Moines, Iowa, will attract attention, and perhaps be received with a justifiable doubt of its entire accuracy. No one, however, will suspect the journal named of any intention to exaggerate the facts relating to this alleged new discovery; those who doubt will do so on the ground of inherent improbability. Certain it is that, if these facts can be fully substantiated, the discovery (or invention, if that be the more appropriate name for it) is of an epoch-making character,—as much so as was the introduction of Bessemer steel.

Two names have been selected for this metal, neither of which appears to be entirely appropriate, and, doubtless, should its merits be established, it will be endowed by the mechanical engineering societies with a more characteristic cognomen. It is called "Damascus steel" and "tempered wrought iron." *The Railway Review* says:

"The most striking feature of the metal is that it may be cast direct from the crucible. It comes from the mold soft, nearly as much so as the wrought iron of which it is made. It can then be forged, welded, and tempered, and in each process it surpasses even the best wrought iron in ease and certainty of manipulation. There seems to be no danger of injuring the metal by burning in the forge. It is soft until tempered, and then it is as hard as the best tool steel. These statements, strange as they may seem, are based upon a series of interesting tests which were recently witnessed at the shops of the Chicago and Northwestern Railway in Chicago.

"The tests referred to consisted of forging a heavy lathe tool from a square bar about two inches square in section, which was heated, tempered, and put in a double driving wheel lathe to turn off a Midvale steel tire, upon which a heavy tool of Mushet steel had been at work. The forging showed the metal to be very tough and ductile under the hammer,—a heavy steam hammer,—and the piece did not fly to pieces at the first blow, as might have been expected from the fact that it was a casting. The tempering was done at a heat high enough to totally destroy steel, and this process was seen to be a simple one, as no drawing of the temper was necessary. The piece was heated very hot and plunged immediately into cold water, where it was allowed to remain until cool. The tool was ground and then put into the lathe, where it did, to all appearances, as good work as the Mushet tool, which it replaced. A severe test was given it, owing to the presence of several hard spots in the tire. A cold chisel was afterward forged from the same ingot, which stood well in chipping cast iron. The only part of the process which was not exhibited in this test was the melting and casting, but the appearance of the sample left no room to doubt that it was cast."

Tests of this metal carried out at the shops of the Cleveland, Canton, and Southern railway are also described as giving equally surprising results, but these statements appear to rest solely upon the assertions of the inventor, and are not confirmed by other testimony. It is even asserted that a cold chisel made of this metal was successfully used to chip out a hard spot in the tire too refractory for lathe tools. It is further stated that "the metal is not hot-short, except when very nearly at the melting point, when, if struck by a steam hammer, it will break up, but can be welded up into a solid piece again. It welds readily in the electric welding machine, as shown by tests made by the Thompson Electric Welding Co., of Lynn, Mass. It welds at a lower temperature than steel. The metal takes an excellent polish, and has been worked successfully into knife blades. The tempering is done at a white heat just below 'sparkling,' and then the tool is dipped until the point is black. The tempered portion has a white appearance, when cool. The degree of hardness seems to follow the temperature to which the metal is heated before quenching, and the only difficulty found in getting men to work it properly is the fear of burning it, which leads them to quench from too low a temperature. There seems to be no danger whatever of burning, and the samples seen were heated in tempering to an extent which would have destroyed steel.

"The process is a simple one, consisting of placing good quality of wrought iron into crucibles, and heating to a pasty state. The tempering and fluxing element, the composition of which is a secret, is then added, and the further application of heat results in melting the mass. It is ready to be poured, after standing about fifteen minutes. Molds for this metal must be of such material as will stand the high heat of the pouring, and yet must be free from gas-producing elements. There seems to be no difficulty in getting castings entirely free from blow holes, and Mr. Dawson says that he is satisfied that it may be cast in intricate molds. He believes it to be applicable to any purpose to which wrought-iron forgings are now put, and in such work its property of being melted should lead to much saving of expense."

To such statements as these, not yet confirmed beyond the authority of Mr. Dawson, we can only apply the old newspaper expression, "important, if true." Nothing need be said by way of enlargement upon the possibilities of such a material, if it can really be added to the present resources of mechanical engineering; every practical mechanic is competent to judge for himself what advances can be made in machinery construction, if cast metal can be given the properties of the best tool steel.

The Modern Electric Traveling Crane.

A VERY good article, entitled "Notes on the Traveling Crane," by Chas. L. Griffin, appeared in *American Machinist* (Dec. 12). The details of construction are gone over, and the essentials of construction considered. As a sample of the character of this article, we quote the following relating to brakes.

"Much ingenuity has been expended upon the design of brakes to automatically check the descent of the load. The familiar Weston brake, though primarily invented for hand-crane service, has been modified and changed into so many different forms for power cranes that it is often a study to reveal its identity. Many a designer, after much mental labor, has brought out a new form of brake, only to find that he had the Weston device in principle, with the addition of some detail which was perhaps a loss rather than a gain. The differential strap brake is often used in some one of its many forms. A brake closely akin to this is operated on the principle of the multiplying friction of a band coiled on a drum. An electric brake is, perhaps, most generally used, in which case the strap or band is operated by a pair of solenoids. A combination of the electric brake and the mechanical brake has been used with much success, and constitutes the so-called duplex system. Much might be said in favor of this system, for it not only secures practically absolute safety against dropping the load, but the action is prompt and perfectly smooth in lowering with heavy loads, when the pumping motion is so apt to occur with a single brake.

"When it is realized that by the reliable action of the brakes alone the load is sustained in mid-air, the freedom from accidents due to their failure best illustrates how well this troublesome problem has been met and solved. The action of a crane in service, handling, say, fifty tons, can but impress one with the tremendous responsibility thrown upon the breaking mechanism. The certainty and precision with which the heavy load is controlled by the brake is remarkable."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering and Mechanical Journals—See Introductory.

The Machine Shop.

3017. Notes on the Traveling Crane. Charles L. Griffin (Deals with electric traveling cranes, and is a very thorough, practical discussion covering all parts of the mechanism). Am Mach–Dec. 12. 3000 w.

3018. Some Mistakes of Mechanicians. W. F. Durfee. Ill. (An instructive and amusing article). Am Mach–Dec. 12. 1500 w.

3062. Segregation at Furnace and Foundry. Thomas D. West (Read before the Foundrymen's Asso. It is not the writer's intention to cover the question of segregation in cast iron, but to call up practical points which confront all in every day practice). Ir Tr Rev–Dec. 12. 3200 w.

3129. The Manufacture of Wire. Frederic A. C. Perrine (Descriptive of the various operations). Elec Engng–Dec. Serial. 1st part. 2200 w.

3149. Fitting Up a Foundry. Charles A. Hague (Describes and illustrates a foundry equipment recently fitted up with cupolas, pressure blowers, elevator, belted power outfit, and somewhat novel molding floor). Am Mach–Dec. 19. 3300 w.

3150. The Development of the Drop Hammer. Ill. C. E. Billings (Interesting and instructive, historically and technically. The first use of drop hammers is attributed to Col. Samuel Colt, in the year 1853. The essential features of a good drop hammer installation are separately treated). Am Mach–Dec. 19 1700 w.

3151. A Shaft Coupling. W. P. Anthony (Describes a very useful and simple coupling that has not been widely used though it appears to be superior to many now in use). Am Mach–Dec 19. 650 w.

*3205. Report on the Lille Experiments on the Comparative Efficiency of Ropes and Belts for the Transmission of Power (Abstract of a paper read before the Inst. of Mech. Engs., and translated by David. S. Copper). Eng, Lond–Dec. 13. 2500 w.

3281. Are Our Cupolas Built Right? John Pettigrew (Suggestions for improving shape of cupolas in vertical section, for practical reasons assigned). Foundry–Dec. 600 w.

3282. Hints Helpful to the Molder Who Does Not "Know How." E. H. Putnam (Causes and cure for scales; difficulty arising from shot iron; tempering sand; venting from cores; gating). Foundry–Dec. 1500 w.

3283. New Methods. H. Hansen (Possible application to repairing imperfect castings). Foundry–Dec. 1000 w.

3284. Aluminum, Silicon and Phosphorus in the Brass Foundry for Special Work. F. J. Davis (General review of the uses of these metals for the purpose named). Foundry–Dec. 900 w.

3398. Distribution of Power at the Works of Brown & Sharpe. Ill. (A good study in belts and belting practice). Ir Age–Jan. 2. 700 w.

3399. The Making of a Skate (Illustrated detailed description of processes, tools and methods). Ir Age–Jan. 2. 5500 w.

3438. Engine Bed and Cylinder Tools. Herman Landro (Illustrated description of an ingenious adaptation). Am Mach-Jan. 2. 1700 w.

3451. A Model Car Wheel Pattern (Illustrated description of a modern car-wheel pattern). Ir Tr Rev–Jan. 2. 400 w.

3452. The Growing Field of Compressed Air. Howard A. Pedrick (A discussion and description of applications of compressed air in machine shop and foundry practice, for the purpose of driving tools and implements). Ir Tr Rev–Jan. 2. 2700 w.

3485. Cutting Square Threaded Screws. Ill. Boyd Harriman (A thorough practical discussion of the different methods of making the so-called square threaded screws). Mach–Jan. 2400 w.

3488. The American Moulder and His Art. Simpson Bolland (An able review of progress in the art of moulding for casting objects in iron). Mach–Jan. 3200 w.

*3490. Defects in Iron Castings. D. Brown (The causes of defects are explained, and their remedies, in venting, coring, mixing metals for the cupola pouring are set forth). Ir & Steel Tr Rev–Dec. 27. 1800 w.

Steam Engineering.

3027. Efficiency of Boilers with Varying Rates of Fuel Combustion. R. C. Carpenter (Experimental data on this subject given and deductions made. Theoretical considerations occupy much of the space devoted to the subject). Power –Dec. 2500 w.

3029. Water Tube Boilers (The first part gives a sketch of progress, and describes and illustrates the Pierpont serial water tube boiler). Lord's Mag–Dec. Serial. 1st part. 1800 w.

3075. Steam Plant at an Anthracite Breaker. H. G. Merrill (Illustrated description of the machinery at South Wilkes-Barre breaker of the L & W. B. Coal Co.) Safety V–Dec. 2000 w.

*3096. Steam Expansion Drop (A review and criticism of A. C. Elliot's paper upon Steam Expansion Drop read before the meeting of the British Asso., at Ipswich. The ground is taken that the clear enunciation of the limit of expansion made, in ordinary language, by Prof. Elliott, is obscured, rather than rendered clearer, by the manthematical analyses which follows and supports the statement). Engng–Dec. 6. Serial. 1st part, 3400 w.

*3103. Water-Tube Boilers. Carlton J. Lambert (Circulation in tubulous boilers of the Garrow type explained and illustrated). Engng–Dec. 6. 1000 w.

*3132. Good Regulation and the Shaft Governor. E. T. Adams (Suggestions toward securing better regulation, with practical hints as to the best method of working, and need of observing certain precautions). Sib Jour of Engng –Dec. 3300 w.

†3171. The Proportions of High Speed Engines. John H. Barr (An attempt to derive empirical formulas from general experience in engine construction. An instructive and interesting paper). Trans Am Soc of Mech Eng–Dec. 2000 w.

†3172. Comparative Tests of Steam Boilers with Different Kinds of Coal. Charles E. Emery (Paper read at the N. Y. meeting of the A. S. M. E. A digest, with references to the information available in regard to a suggestion made at a previous meeting, by Mr. F. W. Dean, that boiler trials should be made on the basis of efficiency,—defined to be the ratio between the total which any given coal can generate by complete combustion, and part of it absorbed by the water heated and the steam generated). Trans Am Soc of Mech Eng–Dec. 10800 w.

3220. Proportioning of Heating Surfaces in Return-Tubular Boilers (General principles which underlie this feature of boiler design. Diversity of practice. The writer thinks the diameters of tubes should be kept down and that in no case is there need of exceeding an outside diameter of 3½ inches). Eng Rec–Dec. 21. 2000 w.

*3248. Remarks on Steam Pipes. J. T. Milton (Abstract of a paper read before the Inst. of Nav. Arch. A consideration of dangers and difficulties to be overcome with results of tests made by the Elmore Copper Co). Elect'n–Dec. 18. 2500 w.

3323. The Utilization of Anthracite Culm at Scranton, Penna. (Records the carrying out, with successful results, attempts to utilize culm as fuel for generating power. The success reached indicates that a vast quantity of power from culm piles may be realized). Eng News–Dec. 26. 1800 w.

*3346. Economic Tests of Boilers. Lavington E. Fletcher (Abstract of memorandum presented by the chief engineer at the annual meeting of the Manchester Steam Users' Asso. Description of boilers, and the character of the tests, with tabulated data from which it is concluded that they are not more economical than Lancashire boilers). Prac Eng–Dec. 20. 1000 w.

*3347. Corliss Engines. Fleming Fitzroy (Proportions of steam ports and valve seat diameters, with diagrams and formula). Prac Eng–Dec. 20. 1700 w.

*3348. On the Surface Condensing Plant at the Newcastle and District Company's Electric Light Works, Forth Banks, Newcastle-on-Tyne. William Cross (Read before the Northeast Coast Inst. of Engineers and Ship-builders. Illustrated detailed description of an interesting installment). Eng's Gaz–Dec. 1800 w.

*3354. Patterson's Suction Draught and Smoke Preventing Apparatus. Archibald Barr (Illustrated detailed description of the system, with tabulated results obtained by a series of experiments at the works of Paul & Co., Dumbarton, Eng). Engng-Dec. 20. 2800 w.

3432. Grate Areas and Heating Surfaces (Editorial, questioning some of the opinions entertained upon this subject, particularly the view that high rates of combustion are necessarily accompanied by imperfect combustion, although the fact is admitted that forcing the combustion in ordinary types of locomotive furnaces generally results in rapid diminution of efficiency). Ry Mas Mech–Jan. 1600 w.

3436. The Power Plant of the Farr Alpaca Company (Illustrated detailed description. Plant designed to supplement water power). Eng Rec–Jan. 4. 1800 w.

3439. Experiments on Steam Pipe Explosions (Condensed account of German experiments carried out at the Royal Dockyard, at Wilhelmshaven, with important deductions). Am Mach–Jan. 2. 1500 w.

3484. Boiler Reform. John J. Hogan (An able review of the causes which have retarded progress in boiler construction, mostly embraced in the phrase "disregard of natural laws," and a clear and concise enunciation of the laws which must be observed in approximating toward the ideal construction). Mach–Jan. 2500 w.

3486. The Steam Engine. F. F. Hemenway (The first part, after introductory matter, begins the discussion of heat, its nature, the unit of heat, the mechanical equivalent of heat, work and energy and combustion). Mach–Jan. Serial. 1st part. 2500 w.

†3515. Test of a 240 Horse-Power Babcock and Wilcox Boiler with Three Different Coals, for the Determination of Economy. Ill. St. George M. Anderson and Edmund J. Burke (The tabulated data derived from this well conducted test and presented in this article are exhaustive, interesting and instructive). Stevens In–Oct. 4000 w.

Miscellany.

*3009. Limits and Possibilities of the Gas

Engine. George Richmond (A consideration of the means suggested for increasing the efficiency of the gas engine). Eng Mag–Feb. 5000 w.

†3050. Tests of a Ten-Horse-Power De Laval Steam Turbine. Ill. William F. M. Goss (Account of a test conducted at the engineering laboratory of the Purdue University. Results tabulated). Trans Am Soc of Mech Eng–Dec. 1700 w.

†3051. Water Power—Its Generation and Transmission. Samuel Webber (Presented at the N. Y. meeting of the Am. Soc. of Mech. Eng. A critical examination of the various turbines in use and of their behavior under specified conditions, and modes of testing them). Trans Am Soc of Mech Eng–Dec. 5000 w.

†3052. Some Experiments with the Throttling Calorimeter. A. A. Goubert and E. H. Peabody (Presented at the N. Y. meeting oi the Am. Soc. Mech. Eng. Describes methods, apparatus, aud experiments, proving unreliability of the throttling calorimeter tests as commonly conducted). Trans Am Soc Mech Eng–Dec. 2000 w.

†3053. Effect of Temperature on Strength of Wrought Iron and Steel. R. C. Carpenter (An investigation conducted in the testing laboratory of Sibley College. Results tabulated). Trans Am Soc of Mech Eng–Dec. 800 w.

†3054. Recording Device for Testing Machine. G. W. Bissell (Describes and illustrates a new device for making an autographic record, as attached to an Olsen testing machine.) Trans Am Soc of Mech Eng–Dec. 600 w.

†3055. The Reliability of "Throttling Calorimeters." J. E. Denton (Presented at the N. Y. meeting. Gives description of method and apparatus, and describes an experimental investigation by which it is proved that without certain precautions, results may be entirely unreliable). Trans Am Soc of Mech Eng–Dec. 3700 w.

†3056. Experiments on the Friction of Screws. Ill. Albert Kingsbury (Presented at the N. Y. meeting. Describes method and apparatus and gives tabulated results with formula upon which calculations are based). Trans Am Soc Mech Eng–Dec. 1500 w.

†3057. Means Adopted for Saving Fuel in a Large Oil Refinery. Charles E. Emery (Presented at the N. Y. meeting. An account of economies secured by the installment of electrical transmission to outlying points to which the conveyance of steam from installed boilers was uneconomical on account of condensation in pipes, and by the additional installment of high-pressure, non-condensing engines operating power pumps). Trans Am Soc of Mech Eng–Dec. 1300 w.

3076. The New York Produce Exchange (Description of machinery and appliances in the building). Safety V–Dec. 1700 w.

3061. A Great Dredge (A description of a 3000 horse-power machine being built at Sparrow's Point, by the Maryland Steel Co., for improving the Mississippi River). Mfrs' Rec–Dec. 13. 1000 w.

*3063. Pilcher's Soaring Apparatus (Illustrates and describes the apparatus, explains its principles, and gives an account of the present state of development of apparatus and system). Prac Eng–Dec. 6. 1800 w.

*3064. Rope and Belt Transmission. V. Dubreuil (Abstract of a paper read before the Society of the Civil Engineers of France. Treats of diameters of pulleys and ropes; linear velocity; distance between pulleys; position of slack and tight strands; ratio of pulleys; kind of ropes; number of ropes; sectional area of ropes; wear of cables at work; balancing pulleys; shafting and bearings; shape of grooves; oiling ropes; friction of ropes and belts. A very practical discussion). Prac Eng–Dec. 6. 2300 w.

*3104. Locomotive for the Glasgow and South-Western Railway (Illustrated detailed description as exhibited by the specifications in the contract). Engng–Dec. 6. Serial. 1st part. 3000 w.

3108. Grinding Cards. Una (A very interesting description of special appliances, devices and methods not generally known). Bos Jour of Com–Dec. 14. 1500 w.

†3110. Comparative Test of a Compound Locomotive and a Simple Locomotive on the Central Railroad of New Jersey. Russell E. Taylor. Charles C. Kenyon, Edward D. Mathey (Tabulated details of construction, description of tests, and tabulated data resulting therefrom, with account of instruments employed, methods, and numerous diagrams). Stevens' Ind–July. 3000 w.

3127. Damascus Steel or Tempered Wrought Iron. Ill. (Describes a new metal which can be cast and yet, it is claimed, can be tempered and hardened as well as tool steel. The importance of this discovery, if confirmed, can scarcely be over-rated). Ry Rev–Dec. 14. 1600 w.

*3131. Suggestions on Boiler Testing. C. E. Emery (Dealing largely with the need of ascertaining the calorific value of different fuels). Sib Jour of Engng-Dec. 2500 w.

3153. The Chicago Motocycle Contest. H. L. A. (Full account of the race with illustrations of motocycles). Am Mach–Dec. 19. 3700 w.

3157. Power from Ocean Waves (A method of utilizing swells, near shores, to pump water in large quantity to heads available for use in driving water-wheels). Min & Sci Pr–Dec. 14. 400 w.

*3203. Wind Motors (First part treats of energy of winds and begins a history of windmills). Ind & Ir–Dec. 6. Serial. 1st part. 1500 w.

3285. Cincinnati's Great Bell. W. J. Tobin (Illustrated description of the moulding and casting of the largest bell ever yet made in the United States. The bell with its appendages weighs 43,000 lbs.) Foundry-Dec. 2000 w.

†3333. Address of Mr. J. T. Brooks (A general dissertation upon the way to attain highest excellence in locomotive engineering). Trav Eng Assn–Sept. 4000.

†3334. What Effect Has the Proper or Improper Manipulation of the Throttle, Cut-off and

Boiler Feed on the Coal Consumption (A short but interesting paper on the subject named, followed by a still more interesting discussion). Trav Eng Assn–Sept. 8000 w.

†3335. How Can the Traveling Engineer Assist in Preventing the Unnecessary Emission of Black Smoke (Brief but interesting paper with extended discussion). Trav Eng Assn–Sept. 4500 w.

†3336. In What Manner Can a Close Record be Kept of Condition of Engines, Amount of Work Performed and Manner of Doing It, Together with Manner in Which Work is Done by Engineer and Fireman, Which Will Serve as Record of Character and Qualification for Advancement of Men? (Report of committee, with discussion). Trav Eng's Assn–Sept. 2000 w.

†3337. What is the Smallest List of Tools, Arranged in the Order of Their Importance, that Traveling Engineers Would Recommend to be Carried on Engines, and What Now Carried Can Be Dispensed With? (Report of committee, with discussion). Trav Eng's Assn – Sept. 3800 w.

†3338. When Traveling Engineers are also Air-Brake Instructors How Can They Best Instruct and Examine the Engineer and Train men, without the Use of an Air-Brake Instruction Car, or Instruction Room? (Report of committee, with very interesting discussion). Trav Eng's Assn–Sept. 10000 w.

†3339. "The Art of Air Braking," from an Engineer's Standpoint, That is to Say, the Care and Manipulation of Engine Equipment (Report of committee, with interesting discussion). Trav Eng's Assn–Sept. 7700 w.

†3340. Could Not the Locomotive Service of the Country be Improved if the Furnishing of Feed Water and Coal was in the Hands of the Locomotive Department? (Report of committee. Gives summary of replies from twenty one members, to questions contained in a circular letter prepared by the committee, and relating to the subject named, with brief discussion). Trav Eng's Assn–Sept. 5000 w.

†3341. How Can Traveling Engineers Improve the Service in Rating Engines' Tonnage versus Number of Cars Hauled per Train? (Communication by P. H. Stack, with discussion. Describes method of rating engines on the Union Pacific. Followed by a letter from General Inspector John H. Harris, also discussed at length, giving an account of the method of rating on the Denver and Rio Grande R. R.) Trav Eng's Assn-Sept. 5800 w.

†3342. How Can Traveling Engineers Reduce the Delays Caused by Hot Boxes and Bearings? (Communications from chairman, William Conger, Mr. I. H. Brown, and Mr. George T. Wells, presented in lieu of a report which was expected, with discussion. The letters and discussion are important and interesting). Trav Eng's Assn–Sept. 5000 w.

3421. Smoke Prevention and Smokeless Furnaces (Discussion of smokeless furnaces and kindred devices, waste due to smoke, hygienic questions, city ordinances relating to smoke, etc., with editorial comments on the desirability, practicability, and means of burning soft coal without producing smoke). Eng News–Jan. 2. 7000 w.

3427. Automatic Oiling (Illustrated description of the Wilson–Whiting–Davis system). R R Gaz–Jan. 3. 800 w.

3429. Tests of Oil Engines (Results of German tests of twenty-seven different engines, with tabulated data). R R Gaz–Jan. 3. 900 w.

3453. The New Tool of Transmission. Oberlin Smith (A general and interesting discussion of electricity as a means of transmitting energy, written in popular style). Ir Tr Rev–Jan. 2. 3200 w.

*3465. Designing a Flour Mill. W. L. Burner (Illustrated by diagrams showing judicious arrangement of machinery with detailed explanations). Am Miller–Jan. 700 w.

*3466. Mechanical Road Carriages. Ill. W. Worby Beaumont (A course of Cantor lectures on this subject. The first lecture is principally historical). Jour of Soc of Arts–Dec. 27. Serial. 1st part. 8000 w.

3483. High Duty Pumping Engines. Thomas Downs (A lecture given before the Robert Fulton Assn., Illinois N. A. S. E. A good study in this department of mechanical engineering, and an able discussion of the principles that should guide construction and design). Sta Eng–Jan. 2000 w.

3487. Modern Data on the Phenomena of Sliding Surfaces. John H. Cooper (These articles will presumably deal with all the phenomena of frictional contact. The first part discusses the friction of flat surfaces, both static and dynamic, and revives the old and oft debated question of the reason why a shaft can be more easily moved endwise in its bearings when revolving, than when at rest, but without throwing any new light upon this mysterious phenomena). Mach–Jan. Serial. 1st part. 2000 w.

3498. Wrought Iron Fly Wheels (Illustrates and describes important departures from ordinary fly-wheel construction, directed toward securing stronger and safer wheels, from designs by Mr. F. P. Sheldon for the Union R. R. Co., of Providence, R. I., and Mr. Edwin Reynolds, of the Edward P. Allis Co. of Milwaukee, Wis.). Power–Jan. 700 w.

3504. The Bennett Bisulphide of Carbon Engine. Ill. Lucius T. Stanley (Descriptive of an engine arrangement, designed by J. R. Bennett, of Philadelphia and being introduced by the Giant Power Co.). Elec Eng–Jan. 1. 1200 w.

†3509. Metallurgical and Other Features of Japanese Swords. Ill. Benjamin Smith Lyman (An exceedingly interesting and instructive account of Japanese forging and tempering by which excellent results are reached through simple methods, some of which appear to have been practically unknown to smiths in western countries). Jour Fr Inst–Jan. 3800 w.

3513. Some Tests of Air Compressors. Ill. A. E. Chodzko (Tests made by the military authorities on the dynamite guns of Fort Point, San Francisco). Jour of Elec-Dec 2800 w.

MINING & METALLURGY

Colorado Placer Mining.

In an article by Prof. Arthur Lakes, published in the *Colliery Engineer* (Dec.), we find the following description of a typical gold placer:

"First a foot or two of black turf in which there is no gold; below that a foot or two of clay with pebbles in it; then a few feet of sandy layers irregularly bedded in streaks, as if formed by eddies and currents. This also is commonly barren or poor. The remainder to bed rock, from thirty to fifty feet, is composed of subangular pebbles and boulders of all sizes, from that of a marble to masses a yard or more in diameter. These are cemented together by gravel and sand, which time, pressure, and solutions of lime and iron-oxid have cemented into a firm conglomerate, which can only be attacked by the pick or by the all-destroying giant nozzle. Such are the placer beds, for which we are indebted to glacier and stream.

"These banks are continuous down both sides of the stream for fourteen miles, but appear thickest on the east side, and especially near the village of Alma and opposite the outlet of the tributary cañon of Buckskin creek. This is the site of the oldest and largest placer workings in Colorado. The banks have been cut back for a long distance, presenting a line of vertical cliffs seventy feet in height for about half a mile in length, channelled by narrow ravines and gashes, as shown in our illustration (Fig. 3), by the inroads of the giants and the cutting back of the flume waterfalls. Some of these cuts are short gashes, not penetrating far into the hill; others lead through long narrow ravines into wide open amphitheaters, surrounded by channelled cliffs, whilst the center is occupied by tall piles of large boulders thrown out and piled up in the course of the work.

"Wending through these piles of *débris* may be seen the pathways of the old abandoned gravel-sluices, telling of the great work done and long since abandoned. It is into one of these amphitheaters where work is still actively going on that we enter through a cut and ravine on the southwest end of the hill. From this ravine issue two long snake-like gravel-sluices debouching onto the open river bottom by many radiating mouths and shorter branch sluices. The water rushes rapidly along the bottom of these sluices, and we can hear the big boulders rolling and bumping along over the riffles which line the bottom. We follow these sluices up the ravine for a thousand feet to where the ravine widens into a broad amphitheater two hundred feet wide by seventy feet deep. Here we see operations in full blast (Fig. 5).

"The first objects that strike our attention are four waterfalls descending the steep bank at the head of the amphitheater, each one cutting back rapidly a sharp, narrow ravine for itself from grass roots down to bed rock. Thus, these waterfalls, each fed by its own ditch on the bank above, cut the bank at the far end of the amphitheater into a series of parallel blocks or slices of ground. Against the sides of these blocks two giant nozzles direct their powerful columns of water with crumbling effect upon the loosely-cemented material, which rapidly fades before them, and mass after mass, undermined, rolls down into the refuse stream and thence into the gaping mouths of the gravel-sluices. The giants, too, speed the boulders and sand on their way by adding their force to that of the refuse stream flowing from beneath the waterfalls. So, sand and gravel and boulders are washed into the gravel-sluices, the bottoms of which are lined with 'riffles' or short cross sections of the trunks of trees placed together like a lot of lozenges, or like a Nicholson block pavement. Both big and little boulders roll rapidly over this block pavement, and the gold, by its gravity, drops into the interstices between the blocks, and is retained there. Its retention and deposition are further assisted by quicksilver thrown in, which has an affinity for gold and collects the finer particles in its soft heavy mass.

"Whilst the boulders and gravel soon find their way to the dumping ground on the open river bed, the gold in its travel stops long before this point is reached. In the center of the amphitheater a tall derrick moves a long arm around over the area by the power of a ten-feet diameter Pelton wheel worked by water, and an undershot nozzle. The use of this derrick we see presently.

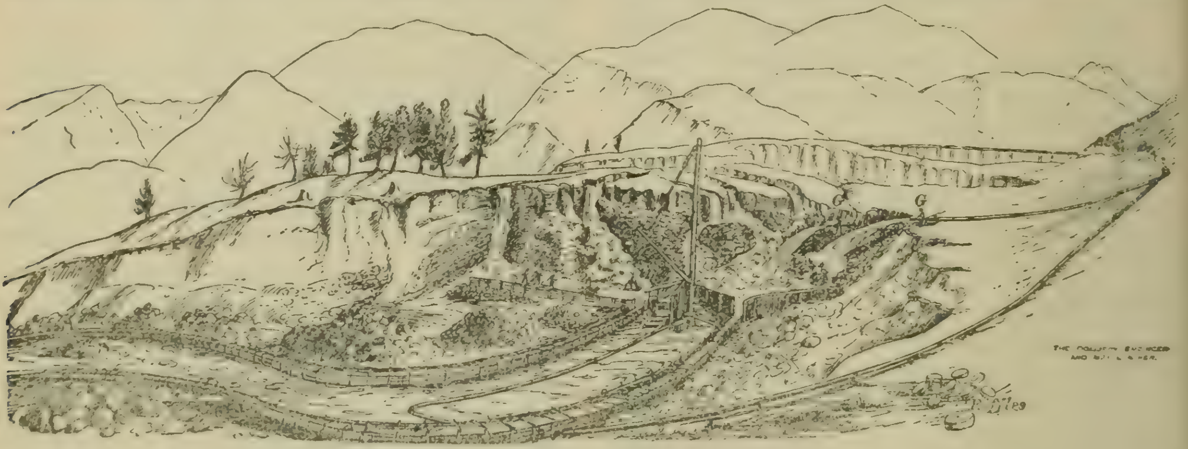


Fig. 5.—Alma Placer. *G. G*, giants.

"One of the flumes is stopped, and its waterfall ceases; the giant nozzle is directed elsewhere; and the pathway of the stream becomes comparatively dry. Men gather into it and pick up the larger boulders, which are too large to pass conveniently through the gravel-sluice. Some of these are so large they have to be blasted. The long arm of the derrick swings around, and the boulders are placed in a large tray or stone boat suspended from the arm of the derrick and swung around to a convenient dumping ground on either side of the sluices. The larger boulders being removed, the gravel and finer pebbles become more exposed, and the nozzle is again brought to play on these, till at last bed-rock sandstone appears beneath, full of cracks and crevices, forming by its gentle dip and irregularities natural riffles and catching places for the gold.

"Now, the bed-rock cleaners go to work and dig up and shovel into the sluice the rotten surface of the sandstone to a depth of a foot or so, below which, experience has shown, no gold passes. They also probe the cracks with their knives, and pick out any stray nuggets that may be concealed there. Again, in the bed of the stream that descends from the flume, men are at work with long-handled shovels 'ground sluicing,'—*i. e.*, helping along some of the boulders, so as to keep the water in as definite a channel as possible and prevent it from spreading."

Compressed Coal For Heating.

In a meeting of the Society Versuchs- und Lehranstalt für Brauerei in Berlin, Herr Gaslich read a paper on coal briquettes. This was published in the *Oesterreichische Zeitschrift für Berg und Hüttenwesen*, and a translation of it appears in *The Colliery Guardian* (Dec. 6). The Saxony coals have such high percentages (50 to 60) of water that it is necessary to dry them before burning or compressing. Drying can be carried on to any considerable extent only where the most powerful presses are at work,—*i. e.*, at a pressure of about fifteen hundred atmospheres. Speaking of the marketing of such blocks of compressed coal, the author says:

"There is no product or manufactured article exhibiting such variations in price, or with which the public is so deceived, as compressed coal, both as regards quality and quantity. There are some works where only surface coal is manipulated, and only an inferior article is produced; in others again, half surface and half pit coal is used, whereby a better-quality product is turned out; and again, there are some where only best pit coal is used, and consequently the best article, commanding a good price, is made. The latter have their own trade marks, which are, however, imitated as closely as possible by the manufacturers of inferior goods, so that it is very difficult for the consumer to find out which is the best. Another practice, opening a wide door for deception, is that of making blocks of different sizes,—some makes will go 35,000, while others are only 18,000, to the wagon load,—particularly as retailers always sell by number instead of by weight. The desire on the part of consumers is to have a clean, bright-looking block, for which they will pay a higher price, although these external indications have no connection with the quality or calorific value of the coal, but merely increase the cost of manufacture.

"For industrial purposes small cubical blocks are the best to use, being easier to shovel up and burning regularly in the furnace without falling to pieces. No concern need be had for smooth surface and clean edges, those being luxuries and unconnected with the quality. It is, however, well to see that the coal is dry and leaves but little dross or ash, and these properties are not discernible to the eye, but must be made the object of experimental determination. Heating experiments made with pressed coal showed that the production of 100 kilos of steam cost from 20 to 26 pfennige (8 pf. = one penny), while with Bohemian brown coal the cost was 30 pf., showing, at least under the conditions obtaining in Berlin, that an inferior pressed coal is appreciably cheaper than high-class Bohemian coal.

"In the discussion on the paper Dr Gronow remarked that, apparently, compressed coals are calculated to replace brown coal, and to some extent hard coal also. The calorific power of the former ranges from 4,500 to 6,000 units, while that of brown coal only varies between 4,500 and 5,000 units. The examination of forty samples of brown coal and eighty of briquettes resulted in an average heating value for the former of only 4,600 units, whereas the pressed coal averaged, 5,300, or some 15 per cent. higher. In practice however, these results do not seem to have been fully confirmed, for, though a saving in the amount of coal used has been effected, the difference does not correspond to what analysis leads one to expect. Two points of superiority possessed by the briquettes are the freedom from smoke, and the very regular fire produced. On the other hand, the high percentage of ash—up to 10 per cent.—tells against them, the brown coals having only from 3.3 to 6.6 per cent."

Much of our own coal which now goes to waste at the mines might be made marketable in the form of briquettes, and sold at a profit.

Indicator Veins.

PROSPECTORS soon learn to know the associations which are peculiar to the ore they hunt for. These are often of an unusual nature and constitute the "indications" which direct them in their subsequent explorations. The "indicator" which is described by Mr. T. A. Rickard in *The Engineering and Mining Journal* (Dec. 14) is a feature of the veins at Ballarat, Australia. "Ballarat East was distinguished for the particular richness of its old river channels or alluvial leads. It was many years before sufficient work had been done to suggest that the line of maximum richness was coincident with the occurrence, in the bedrock underneath, of certain quartz veins of peculiar character. In 1871 Mr. Morgan Llewellyn pointed out this feature. In Dec. 1888, Mr. E. J. Dunn described a similar occurrence in the neighboring district of Wedderburn.* In September 1893, the writer himself contributed a note † on the subject, and still more recently Mr. William Bradford read a short paper ‡ before the Australasian Institute of Mining Engineers.

"The Indicator is essentially a thin bed of dark slate of varying width, which in some parts of the region has undergone crushing and then becomes a clay, and in others is so mineralized as to be distinguished as a small seam of iron pyrite. At the end of the 700 ft. level in the New Normandy mine it was slightly over $\frac{1}{16}$ inch thick, and carried pyrite imbedded in crushed black slate. In a cross-cut nearby it became a small vein of quartz, an infrequent modification in its composition. In the adjoining mine—the Prince Regent—it was ¼ inch thick and carried both pyrite and black clay. Where black clay is replaced by quartz, the occurrence of rich ore is found by experience to be unlikely. The characteristic of the gold occurrence lies in the fact that the cross-veins or spurs of quartz which traverse the nearly vertical Silurian beds at a strong angle are valuable for their gold contents only in the close vicinity of the Indicator.

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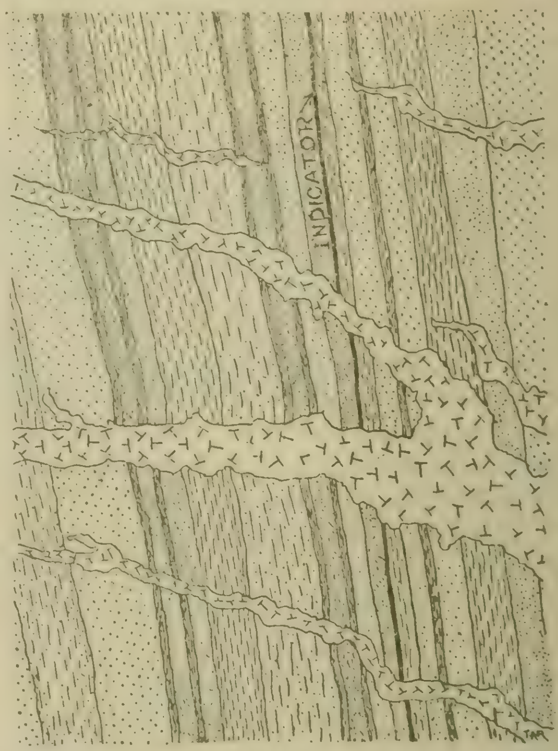
* "Report on the Country in the Neighborhood of Wedderburn and Rheola" Quarterly Report of the Mining Department of Victoria.

† "Certain Dissimilar Occurrences of Gold-Bearing Quartz." Proceedings of the Colorado Scientific Society, 1893.

‡ "The Indicator Feature in Some Gold Occurrences."

"The band of country enclosing the Indicator is ribboned,—that is to say, it consists of closely alternating thin beds of slate and sandstone of varying shades of gray. These, with the Indicator, which is one of them, are crossed and slightly dislocated by the quartz veins. The latter are irregular in their behavior and consist of simple white quartz (with only an insignificant percentage of iron pyrite), which is notably gold-bearing on either side of the indicator for a distance which differs at different places, but is usually comprised within the width of an ordinary drift.

"We may conceive this seam of black slate as a layer of fine silt or mud, full of minute remnants of vegetable life laid down upon the floor of the Silurian sea, subsequently covered by alternating layers of sand and silt, which, in the patient hands of time, became the sandstone and slate of to-day. The vegetable matter became carbonized, and, as in ordinary precipitation of gold in the chlorination process, became the agent compelling the subsequent deposition of gold from circulating solutions. The association of graphitic slates and shales with gold ore of notable richness is a matter which has come under the observations of many. They present a coincidence of evidence which, while it may be possible of explanation in some other way than that above suggested, must yet, in default of such stand as a very remarkable testimony upon the great subject of the origin of gold ores in veins."



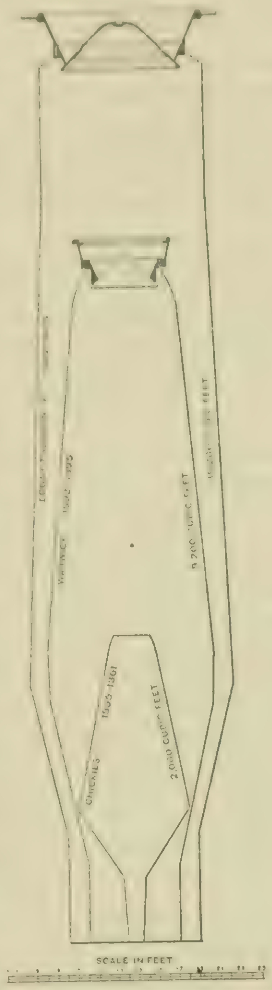
GEOLOGICAL SECTION SHOWING "INDICATOR."

A glossary of stamp-milling terms follows the above description, giving the American term with the English and Australian equivalent.

Development of Iron Blast-Furnace Practice.

In an article, "Forty Years of Progress in the Pig-Iron Industry," in the *Iron Age* (Jan. 2), contributed by Mr. John Birkinbine, there are some interesting notes on early methods, from which we abstract as follows:

"In the year 1855 a majority of the blast furnaces of the country used charcoal, and were operated by cold blast driven into the furnace crucible by power supplied from near-by streams; but it was in this year that the quantity of pig iron made in the country by anthracite coal first exceeded that made with charcoal. Bituminous coal, however, did not outrank charcoal as a blast-furnace fuel until 1869.



The stacks which were supplied with mineral fuel, although generally of larger dimensions than those depending upon vegetable fuel, embodied similar constructive details. The furnaces were massive stone structures braced by iron, beams and bars; the crucible was of small diameter, but of considerable height, terminating in flat boshes, the hearth, crucible and boshes being constructed of heavy sandstone blocks, neatly jointed. The in-wall, lined with soapstone or firebrick, terminated at a tunnel head-plate, through the opening of which the furnace gases escaped, except where these were in whole or in part diverted under boilers, and hot ovens placed at the level of the throat of the furnace. For one-half of the interval of time covered by the publication of the *Iron Age* the flames from gas ignited at the tunnel-heads of blast furnaces were beacons indicating at night the locations of these industries, and the melancholy wheeze of the leather-packed piston, slowly moving in wooden tubs, could be heard at many furnaces. The iron, as it was liquefied, was collected in and tapped from a fore hearth, and the cinder withdrawn under a tymp and weight plate, the latter being occasionally lifted for the purpose of working the furnace with bars and removing with large shovels unconsumed fuel, imperfectly reduced ore, &c. Furnaces 45 to 60 feet in height, with boshes 12 to 14 feet in diameter, were noteworthy as large plants, and an average output of twenty-five tons of pig metal per day was considered an excellent work for such a furnace. The chemist was practically unknown around iron works, the iron produced being sold by fracture and gaged as to quality by its behavior under the rolls or hammer or in the foundry. These qualities were designated by the terms 'cold short,' 'red short,' 'neutral,' &c., and the grade by numbers of 'foundry' or 'forge' iron.

"The three furnaces selected as illustrative are in Pennsylvania. The larger one, in Allegheny County, Pa., used coke as fuel; the two which are smaller are located in the eastern part of the State, and were constructed to use anthracite coal. The Chickies blast furnace, near Columbia, Pa., was originally built in 1846, and in 1855 had a bosh diameter of 10 feet 10 inches, and a height of 40 feet, making in the following six years five blasts. In 1861 the stack was made 5 feet higher, and in two campaigns of 44 and 60 months respectively 1.67 tons of anthracite and 2.19 tons of ore were required per ton of pig metal. Subsequently the furnace was rebuilt to larger size."

The Warwick furnace of Pottstown, Pa., was built in 1876 and rebuilt in 1886, and hot-blast stoves, cooling plates, etc., were added in 1892, at which time but 2250 to 2327 lbs. of fuel were required per ton of pig iron, the ores averaging 61 to 63 per cent. of iron. The average weekly output at the end of 1894 was 976 gross tons, while as high as 1,100 tons per week were produced during 1895. These are large figures compared with its first year's run, where but 189.5 gross tons were produced per week.

At Braddock, Pa., the nine Edgar Thompson furnaces have been doing excellent work, having a total production in sixteen years of six million tons of pig iron. "The fuel and average daily product showed great improvement, until in 1889 furnace F had an average coke consumption of but 1,920 pounds per ton of iron, 310 tons being the daily output. In the latter part of 1894 the eight furnaces which were running on Bessemer metal averaged 11,000 tons per month, the fuel consumption being between 1,900 and 1,950 pounds, including allowances for loss and waste, which for a month or more has fallen below 1,760 pounds."

"Our pig-iron industry has not developed by multiplying plants, but by improved practice. The large stables, which were a necessity for nearly every blast furnace in 1855 to accommodate a hundred or more draft animals, have been supplanted by moderate-sized locomotive houses; the flaming tunnel-head has been extinguished, and gases utilized to heat the blast and supply steam; the bridge-house connecting the tunnel-head to a near-by bank has been displaced by steam elevators; the small wooden casting-houses have grown into large iron and brick structures. The blast of 1,000 to 3,000 cubic feet per minute delivered at from 1·2 to 5 pounds pressure and from atmospheric temperature of from 600 degrees to 900 degrees F. has been intensified, until it is now supplied at from 1,000 to 1,500 degrees F., under pressure of from 10 to 15 pounds per square inch and in volumes exceeding 30,000 cubic feet per minute to one furnace stack. The cinder, instead of being dragged from the tymp by long hooks in the keeper's hands, flows into ladle cars, which are hauled to the dump by locomotives, and at a large steel works much of the iron made is similarly handled in the liquid state. The ore and flux, which were prepared by hand hammer or thrown into the furnace in great lumps, are now reduced in size by rock breakers, and in all parts of the furnace plant and in transporting materials labor is economized, until to-day, in making a given quantity of pig iron, but one-fifth the labor is necessary that was required forty years ago."

Coaldust Fuel.

In a paper before the Prussian Union of Boiler Inspectors a paper was read by Mr. C. Schneider which is abstracted by *The Colliery Guardian* (Dec. 20) as follows: "In June 1894, three trials were made of the Schwartzkopf system of utilizing powdered coal as a boiler fuel. The boiler used was two-flued, the coaldust apparatus being fixed in front of one flue, the other being divided longitudinally by a partition, so that the hot gases traversed the length of the boiler three times before passing into the chimney. It rested on three cast iron stools, had no special setting, and therefore the loss of heat by conduction and radiation was unusually high. The results of the experiment did not, therefore give a sufficiently clear measure of the effectiveness of the fuel-supply apparatus. Three kinds of coaldust were used of calorific values 7,323, 7,861, and 4,960 heat units respectively. The heats utilized were 60.23 per cent., 59.10 per cent., and 59.66 per cent. respectively. The temperature of the chimney gases and the percentage of carbonic acid were observed at intervals. The average temperature during the three trials were 530° C., 522° C., and 478° C., respectively. The chimney losses were 19.92 per cent., 18.66 per cent., and 22.01 per cent., respectively, of the total heat of the fuel; the radiation losses were 19.88 per cent., 22.25 per cent., and 18.33 per cent. respectively." The author gives the advantage of coaldust fuel as: the most perfect combustion, smokelessness, little labor required, independence as to kind of fuel, adaptability, preservation of boiler, and ease in removing fire; the disadvantages are grinding the coal into dust, necessity of mechanical feed, ashes in tubes of boilers, and dust in boiler house.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

3047. Copper Refining by Electricity. H. C. Garneau (Description of process which is said to be both cheap and rapid). Elec Age—Dec. 14. 1200 w.

3085. Improved Method of Handling Pulp in Silver Mills. L. W. Tatum (Description of a method of testing a plant showing how the capacity was increased, the losses reduced and the expenses cut down by intelligent arrangement). Eng & Min Jour—Dec. 14. 1000 w.

*3092. Coal Washing and Coke Making Plant. Ill. (A coal washer whose principal feature is a settling chamber which allows the fine coal to settle and the water to be used again immediately. The banks of coke ovens in connection are of the Coppée type). Eng, Lond—Dec. 6. 1600 w.

*3105. The Employment of Compressed Coal for Heating Purposes (Translated from *Oesterreichische Zeitschrift für Berg-und Hüttenwesen*. A description with statement of advantages and disadvantages of coal briquettes. Forty samples of brown coal gave a heating value of 4600 units, while briquettes gave 5300, or 15% higher. The evaporative value is, however, less). Col Guard–Dec. 6. 1000 w.

3124. Value of Raw Materials in Iron Making. William B. Phillips (Read before the Alabama Industrial and Scientific Society. Many interesting points in furnace practice are brought out. Eleven irons are given, with the burden required in each case). Tradesman–Dec. 15. 1900 w.

3125. Notes on Improved Methods of Cokeing. John S. Kennedy (Description of the beehive, Otto-Hoffman, and Semet-Solvay Coke ovens, with a statement of the qualifications of a good coke for metallurgical purposes). Tradesman–Dec. 15. Serial. 1st part. 3000 w.

3158. The Basic Blow. F. E. Thompson (The conditions and method of working are ably described, much data derived from practice being given ; the regulation of temperature is fully treated). Ir Age–Dec 19. 3400 w.

3159. Fusibility of Bottom Sand. Charles Ferry (The results of chemical and physical examinations of refractory sands intended for furnace hearth bottoms. The author advocates chemical tests). Ir Age–Dec. 19. 2200 w.

3180. The Chemistry of the Cyanide Process —Is Zinc Potassium Cyanide a Solvent for Gold? J. S. C. Wells (The writer concludes from his argument that zinc potassium cyanide is a solvent for gold, but is valueless in the presence of free potassium cyanide, hence of no benefit in the cyanide process). Eng & Min Jour-Dec. 21. 1000 w.

3181. Pan Versus Tina Amalgamation (Additions to and criticism of a paper by Mr. Pazos on the use of copper in amalgamation. The author gives the effect produced by substituting iron for copper at the Bolivian silver mills). Eng & Min Jour–Dec. 21. 1500 w.

†3185. Temperature of Gases from Lead Furnaces. Malvern W. Ills (The method used in the temperature determinations is fully explained. The author says the separation of slag from matte is more perfect at higher temperatures). Sch of Mines' Quar–Nov. 2500 w.

*3202. The History of Mond's Nickel Extraction Process. Ludwig Mond (Abstract of a paper read before the N. Y. Society of Chemical Industry. History of the discovery of nickel carbonyl, and its application to the Mond process). Ind & Ir–Dec. 6. 1900 w.

*3209. Present Position of Aluminum (Brief outline of the growth of the industry, with a table giving the price at various periods. In 1856 it was £18 per lb. ; in 1895 it was 1s. 6d. per lb.). Ind & Ir–Dec. 13. 900 w.

3240. Ideal Steel. B. F. Spalding (The qualities necessary to make a steel ideal are enumerated). Age of St–Dec. 21. 1800 w.

3286. Reduction Works of the Compania Huanchaca de Bolivia. K. F. L. (Description of a large silver reduction plant in the interior of Bolivia). Eng & Min Jour–Dec. 28. 2400 w.

3290. Hainsworth's Cylindrical Casting Ladle (Consists of a horizontal cylinder revolving on runnions, and is applied to Bessemer practice. The accompanying drawings fully explain construction and operation). Ir Age–Dec. 26. 3300 w.

*3301. Coal-dust Fuel. C. Schneider (On the use of coal dust in a boiler as fuel. The heating effect was 78% of the calorific capacity of the fuel). Col Guard–Dec. 20. 900 w.

3384. The Copper Industry of the United States. James Douglas (The article contains a résumé of the early history of copper production and its subsequent development. A large amount of valuable information is given). Ir Age–Jan. 2. 4500 w.

3386. The Lead Industry of the United States. Edward A. Caswell (A general review of the industry with conditions which have influenced the trade). Ir Age–Jan. 2. 4000 w.

3387. The Nashua Open Hearth Furnace of 1867. Ill. S. T. Wellman (An early steel melting furnace built at South Boston. Various sections are given which fully illustrate the construction). Ir Age–Jan. 2. 600 w.

3388. Development of American Wire Rod Rolling. William Garrett (An interesting history of the competition with English rods and wire, and an account of how the early difficulties in manufacture were overcome, The article ends by giving some valuable statistics). Ir Age–Jan. 2. 6000 w.

3389. Forty Years of Progress in the Pig Iron Industry. John Birkinbine (A large part of the article is devoted to the development of blast furnaces, giving diagrams of the types of 1855, 1890, and 1895.) 5000 w.

3390. Early Iron Making in Chicago. O. W. Potter (History of the mills from 1857 to the present). Ir Age–Jan. 2. 2200 w.

3391. The Iron Industry of the Lehigh Valley. Oliver Williams (Interesting reminiscences of this great iron producing region). Ir Age–Jan 2. 1800 w

3393. Steel Rails in the United States. Robert W. Hunt (Early history and reminiscences of Bessemer practice). Ir Age–Jan. 2. 2000 w.

3394. Steel Rails in 1869 (Reprinted from the Iron Age, Nov. 11, 1869, when steel rails were being first extensively introduced). Ir Age–Jan. 2. 3500 w.

3396. The Mines and Manufactures of Pennsylvania in 1866 (Extracts from a series of articles published in *The Iron Age* in 1866, descriptive of the observations made during an excursion, accompanying David A. Wells, special commissioner of Internal Revenue). Ir Age–Jan. 2. 2400 w.

3397. The American Iron Trade Since 1870 (A valuable epitome of progress). Ir Age–Jan. 2. 9500 w.

3417. Copper Refining by Electricity. H. C. Garneau (A concise description including the recovery of gold and silver). Min & Sci Pr–Dec. 28. 900 w.

*3442. Diffusion and Segregation of Metalloids at the Furnace and Foundry, and Methods for Lessening Their Final Evil Effects. T. D. West (Abstract of a paper read at the meeting of the Foundrymen's Assn. (U. S. A.) The variation in composition is ably discussed). Ind & Ir–Dec. 27. 3000 w.

*3445. Sodium in Aluminium (A paper read before the Academie des Sciences in Paris, by M. Moissan on the effects of various metals when associated with aluminium, stating that it is rapidly converted into alumina, especially in the presence of water). Ind & Ir–Dec. 27. 1300 w.

3448. Iron Works of the Mahoning Valley (Illustrated description). Ir Tr Rev–Jan. 2. 2200 w.

3454. Most Modern of Charcoal Furnaces. Ill. (Complete description of furnace, stoves, dust catcher, charcoal ovens, well illustrated by sections, plans and views. The furnace is 60 ft. high with 12 ft. bosh). Ir Tr Rev–Jan. 2. 1900 w.

*3477. The Reduction of Manganese in Blast Furnaces. Franz Büttgenbach (Translated from *La Revue Universelle des Mines, de la Metallurgie, &c.* Estimation of the quantity of manganese that will enter into pig iron). Col Guard –Dec. 27. 2300 w.

*3489. The Training of Metallurgists. A. H. Sexton (Abstract of a presidential address delivered before the West of Scotland Iron and Steel Inst., Glasgow. A very interesting and instructive discussion on the systems of education in use, and the qualifications that have to be met). Ir & Coal Tr Rev–Dec. 27. 5000 w.

†3511. Structural Steel. James Christie (A popular lecture in which the history, process of manufacture, testing, necessary properties, etc., are briefly reviewed). Jour Fr Inst–Jan. 4500 w.

3521. Proposed Standard Structural Shapes (Report of a committee of the Assn. Am. Steel Mfrs. giving drawing of sections of I beams and channels, the general formulæ for weight, strength, and moment of inertia of such sections, and tables of different weights and dimensions). Ir Age–Jan. 9. 450 w.

3528. The Southern Pig Iron Market (A commercial paper giving the production of the southern states, the distribution of shipments of the Tennessee Coal and Iron Co., and suggestions toward improving the market). R R Gaz –Dec. 13. 1200 w.

3538. Manufacture of Carborundum. Ill. (An excellent description of the method and furnace employed in the production of this new abrasive. It is a carbide of silicon produced in an electric furnace, 16×6×5 ft. in size, working at 6000 to 7000 degrees temperature). Min & Sci Pr–Jan. 4. 1500 w.

3539. The Fauvel Process (Address of the inventor before the stockholders—the process consists in a gradual roasting up to 1600°, then plunging into water and treated with mercury). Min & Sci Pr–Jan. 4. 1200 w.

Mining.

*3005. Gold Mining in the Southern States. H. B. C. Nitze (A statistical geological review of the gold ore deposits in the southern states, and of the methods of working them). Eng Mag–Feb. 4500 w.

3031. Routes to the Yukon (Discussion of the various possible routes to the gold placers along the Yukon River, showing their relative merits). Min Ind & Rev–Dec. 5. 1000 w.

*3032. Prospecting for Placer Gold. Arthur Lakes (A description of Alma Placer, South Park, Colo. The method of economically handling large quantities of gold-bearing soil in this typical placer is treated in a detailed manner and illustrated by sketches). Col Eng–Dec. 5000 w.

*3033. Gold and Silver Mining. Ill. Francis T. Freeland (Timbering for precious metal mines in Colorado. The methods of working and conditions which influence the methods of timbering). Col Eng–Dec. Serial. 1st part. 1800 w.

*3034. Iron Ore Mining. H. H. Stoek (The mining and washing of iron ores at Scotia, Penna). Col Eng–Dec. 3000 w.

*3035. Electric Plant at Essen Mines (A description of the largest electric mining plant in America. It is located at the Essen Mines, at Federal, Pa.). Col Eng–Dec. 2400 w.

3036. Colorado's Golden Era (A short general description of the principal properties from the *N. Y. Sun*). Sci Am Sup–Dec. 14. 3300 w.

3060. Gasoline Engines in Mines. Ill. (Brief description of gasoline engine hoisting and pumping installations in California). Min & Sci Pr–Dec. 7. 900 w.

3086. The Indicator Veins, Ballarat, Australia. T. A. Rickard (A valuable article. The indicator is a thin bed of decomposed slate with pyrite. lying parallel to the gold bearing strata. A glossary of stamp mill terms used in America, giving the English and Australian equivalent, accompanies the article). Eng & Min Jour–Dec. 14. 2000 w.

*3112. The First Discoverer of Gold in New Zealand (An entertaining article from the Auckland "Weekly News" giving a history of the early prospecting in New Zealand). Aust Min Stand–Nov. 16. 3300 w.

*3113. Mineral Bearing Veins (A general article treated in an elementary manner). Aust Min Stand–Nov. 16. 2200 w.

*3154. Electric Rock Drills. Ill. (Description of an electric percussion rock drill in actual operation). Stone–Dec. 1400 w.

*3155. An Incline Quarry Railway. Ill. (A 45° incline, 300 ft. long, into the side of the mountain at Rutland, Vt., for hoisting marble). Stone–Dec. 500 w.

3178. Dry and Wet Crushing of Gold Ore (History of the substitution of wet for dry crushing and showing the tendency back to dry crushing by rolls, followed by a leaching process for extraction of the gold). W Min Wld–Dec. 7. 2000 w.

3182. The Minerals of the Sierra de Uspallata, Argentine Republic. G. Ave-Lallemant (Treating of the geology and mineralogy of the ores mined). Eng & Min Jour–Dec. 21. 850 w.

3183. Steam Shovel and Derrick Placer Mining in Idaho. John B. Hastings (Illustrated description). Eng & Min Jour–Dec. 21. 800 w.

*3199. The Limitation or Localization of Colliery Explosions. James Ashworth (Discussion with examples of the apparent preference of some areas to others in mine explosions). Col Guard–Dec. 13. 2500 w.

*3200. Mines and Works of the Commentry-Fourchambault Company (From a descriptive notice prepared for the International Jury at the Bordeaux Exhibition. The various collieries are briefly described. The iron and steel works, dating from 1825, employ 2700 men, while the mines have 6500 employees. The yearly output is 1,000,000 tons of coal, coke, and briquettes; 30,000 tons of pig iron, and 40,000 tons of finished iron and steel). Col Guard–Dec. 13. 2500 w.

*3201. Shaft Sinking by Congelation. Messrs. Saclier and Waymel (Abstract of a paper prepared by the Inst. of Civ. Engs., from the *Bulletin de la Société de l'Industrie Minérale*. Itemized cost statements are given. The paper contains much of value). Col Guard–Dec. 13. 3000 w.

*3216. Dry Crushing Experiments. Franklin White (Detail results of tests of gold ores for the purpose of recovering the gold in the tailings and sluices. Wet crushing consisted in crushing, amalgamating, concentrating, cyaniding of sands, of sluices, and retreatment of concentrate; the dry process would require crushing, cyaniding, concentration, possibly amalgamation on small scale, and treatment of concentrates). Aust Min Stand–Nov. 2. 2000 w.

3273. Ancient Quartz Mining. I. B. Storch (Description of some ancient (200 B. C.) methods of mining gold). Min & Sci Pr–Dec. 21. 500 w.

*3275. The Useful Minerals of Tasmania. A. Montgomery (The minerals are considered with regard to their geological associations, and their economic importance). Aust Min Stand–Nov. 23. Serial. 1st part. 3400 w.

*3276. The Rand in 1886. Fred Alexander (Reminiscences of the Early Gold Discoveries in South Africa). Aust Min Stand–Nov. 23. 2200 w.

3287. Coal in Colombia (Short description of the various localities where coal is found). Eng & Min Jour–Dec. 28. 1000 w.

‖3288. The Zinc Mines at Aurora, Missouri. Ill. H. K. Landis (The article contains the production of all ores since 1890, the prices since 1886, a typical set of mining rules, geological sections, and two views of plants). Eng & Min Jour–Dec. 28. 1100 w.

3289. Coal in Western North Carolina. William B. Phillips (An unexpected discovery of coal and mineral oil. The find is of considerable geological interest). Eng & Min Jour–Dec. 28. 1400 w.

*3300. Measuring the Pressure of Gas in Coal. M. A. Simon (Abstracted from the *Annales des Mines*. Experiments made in a French colliery to determine under what pressure the gas was held enclosed by the coal. The maximum pressure was observed at the bottom of a bore-hole 39 ft. deep, as being 105 lbs. per sq. in.) Col Guard–Dec. 20. 2600 w.

*3302. Kootenay Mines of British Columbia. From *Imperial Institute Journal* (An interesting description of this gold producing region). Col Guard–Dec. 20. 1100 w.

*3303. The Employment of Regular Curves in Driving Headings. Ill. P. Krassnig (Instructions for laying out regular curves without a transit). Col Guard–Dec. 20. 500 w.

*3317. Temporary and Permanent Repairs to a Winding Shaft. Ill. (The trouble was caused by a movement of the strata forcing in the masonry lining of the shaft. Piles were driven into the loose material and the surface held in place by cross timbers, until the wrought iron tubing lining, backed by concrete, could be inserted). Eng, Lond–Dec. 20. 1100 w.

*3320. A New Coal Washer. Ill. (A new form of coal jig used in France). Eng, Lond–Dec. 20. 1800 w.

3385. Copper Mining at Lake Superior. John Stanton (A general description). Ir Age–Jan. 2. 3000 w.

3406. Amendments to the Nova Scotia Mines Act (A report before the Mining Society making various recommendations for the consideration of the law makers. Mining education was discussed and the nature of the instruction specified). Can Min Rev–Dec. 9000 w.

3407. A Mineralized Zone in Nova Scotia. Henry S. Poole (A compilation of notes on the various ore-bearing localities of Nova Scotia, with references and map). Can Min Rev–Dec. 4500 w.

3408. The Capacities of Coal Cutting Machines. W. Blakemore (An interesting comparison of the work done by three coal cutting machines at the Dominion, No. 1 Mine, Nova Scotia, with discussion). Can Min Rev–Dec. 3000 w.

3449. Lake Superior Iron Ranges. John Birkinbine (A general article on the conditions of working). Ir Tr Rev–Jan. 2. 2800 w.

3455. The Mineral Interests of the South in 1895. Wm. M. Brewer (The rare minerals—coal, iron ore, building stones, gold, copper, lead, clays and cement are fully treated). Tradesman–Jan. 1. 10000 w.

3457. The Coal Interests of the South. Ill. J. J. Ormsbee (A review of the coal operations in each of the Southern States, with description of a typical coal mine). Tradesman–Jan. 1. 6000 w.

*3476. Sudden Outburst of Gas in a Non-Fiery Mine. M. Leproux (From a communication to the *Annales des Mines*. Supposed to have been caused by a flow of marsh gas from an adjoining swamp, tapped by a bore-hole). Col Guard–Dec. 27. 2300 w.

*3478. A New Mining Theodolite (From *Berg.-u. Hüttenmanische Zeitung*. The Cséti theodolite is hung from the roof. Advantages claimed are great speed and ease in working in inclined headways). Col Guard-Dec. 27. 1700 w.

*3492. The Mount Bischoff Tin Mine, Tasmania. Ill. Henrich Wilhelm Ferdinand Hayser and Richard Provis (Abstract of a paper read at the Inst. of Civ. Engs., on the geology, method of mining, ore dressing, cost, losses, and water supply. The dressing works are illustrated). Ir & St Tr Jour–Dec. 28. 4000 w.

*3496. Mining and Metallurgy of Quicksilver in Mexico. James Mactear (A paper read at a recent meeting of the Inst. of Mining and Metallurgy. The various mines are briefly described). Min Jour–Dec. 28. Serial. 1st part. 3500 w.

*3497. Quicksilver Mining in the District of Guadalcazar, State of San Luis Potosi, Mexico. Henry F. Collins (A paper read before the Inst. of Mining and Metallurgy. The deposits are described with the mineral associations. An excellent paper). Min Jour–Dec. 28. Serial. 1st part. 1800 w.

*3507. Distribution of Power in Collieries Llewelyn B. Atkinson (A paper read before the South Wales Inst. of Engs. Dealing with the question of the economical production of power, with some remarks on the mechanical power in collieries). Elec Eng, Lond–Dec. 27. 4500 w,

Miscellany.

†3114. Comparative Taxonomy of the Rocks of the Lake Superior Region. N. H. Winchell (A comparison and explanation of the difference in nomenclature, between that of the author and Messrs. Walcott and Van Hise). Am Geol–Dec. 1800 w.

†3115. River Valleys of the Ozark Plateau. Oscar H. Hershey (The geological history of this region and the effects of erosion are fully developed). Am Geol–Dec. 7000 w.

†3116. A Study of the Belvidere Beds. F. W. Cragin (A distinctly geological discussion.) Am Geol–Dec. 9000 w.

3176. A Compressed- Air Power Transmission Plant in California. Ill. (The water, which is conveyed about five miles in a 20 in. steel pipe, with a maximum head of 775 ft., drives an 18 ft. 6 in. diameter Pelton wheel. The wheel is built on the bicycle plan, makes 110 revolutions per minute; it is direct-connected with two air compressors which deliver air at 90 lbs. per sq. in. pressure to the drills, 1000 ft. away). Eng News–Dec. 19. 800 w.

†3186. The Assay of Platinum. Edmund H. Miller (After reviewing the known methods in detail a "proposed method" is given for the assay of platinum in alloys or ores.) Sch of Mines Quar–Nov. 4000 w.

†3187. Lecture Notes on Rocks. J. F. Kemp (A very instructive discussion on the composition and classification of rocks. A tabular scheme is presented). Sch of Mines Quar–Nov. 7000 w.

†3253. On Silicides of Iron. G. De Chalmot (Experimental results obtained in the electric furnace). Jour Am Chem Soc–Dec. 400 w.

†3254. The Volumetric Estimation of Manganese. George Auchy (A comparison of Williams and Volhards methods, giving parallel analyses). Jour Am Chem Soc–Dec. 1200 w.

†3255. On the Estimation of Phosphoric Acid by Titration of the Ammonium Phosphomorlybdate Precipitate with Standard Alkali. B. W. Kilgore (The results of comparative analyses are given, with the idea of finding the best method, at the laboratory of the N. Carolina Experiment Station). Jour Am Chem Soc–Dec. 4800 w.

†3268. On the Composition of the Ohio and Canadian Sulphur Petroleums. Charles F. Mabery (Presented to the Am. Acad. of Arts and Sciences. The oils are considered peculiar by reason of the sulphur constituent. The chemical examination into their composition is fully described). Am Chem Jour–Dec. Serial. 1st part. 10000 w.

†3365. The Quarries in the Lava Beds at Meriden, Conn. William M. Davis (Three quarries in the Triassic (Newark) formation near Meriden, showing the vesicular upper surface of one lava bed under the dense basal portion of a later flow, and a number of fractures dislocating the double flow. Relation of these features to the geological structure of the district). Am Jour of Sci–Jan. 4600 w.

†3367. The Form of Isolated Submarine Peaks. G. W. Littlehales (The derivation of an equation whose curve will represent the contour of certain submarine mountain peaks). Am Jour of Sci–Jan. 500 w.

†3368. Section of the Cretaceous at El Paso, Texas. T. W. Stanton and T. Wayland Vaughan (The geological succession of rocks 698 ft. in thickness, with their accompanying fauna). Am Jour of Sci–Jan. 1500 w.

†3369. On the Epidote from Huntington, Morse, and the Optical Properties of Epidote. E. H. Forbes (Chemical and optical investigation of a specimen resembling zoisite). Am Jour of Sci–Jan. 1350 w.

3392. Pittsburg as an Iron Center. William Metcalf (Setting forth the advantages possessed by the city by reason of its vicinify to oil, coal and transportation; also discussing the smoke and labor problems). Ir Age–Jan. 2. 2700 w

3395. The Lake Ore Trade. F. B. Richards (General description). Ir Age–Jan. 2. 3000 w.

*3475. The Technical Literature of the Year. H. G. Graves (A notice of some of the principal articles appearing during the year on mining and metallurgical subjects). Col Guard–Dec. 27. 2700 w.

*3479. On the Occurrence of Lignite and Anthracite Around Hudson Bay, Canada. Robert Bell (A paper read before the General Mining Association of Quebec. The characteristics of the coal are given with notes on previous observations). Col Guard–Dec. 27. 2000 w.

MUNICIPAL ENGINEERING

Smoke Prevention.

In an editorial in *Engineering News* (Jan. 2) the writer undertakes to answer the following questions: "(1) Has the citizen a right to demand that his neighbor shall not foul the atmosphere with smoke, if he can avoid it by any reasonable effort? (2) Is it possible, from a mechanical and business point of view, to burn soft coal without producing smoke in offensive quantities? (3) If it is possible, what is the best way to work to bring the reform about?"

The first of these questions is answered affirmatively, and the right affirmed is so obvious that we will not dwell upon the argument by which the validity of this answer is sustained.

As to the second question, it is alleged that "the secret of smokeless combustion" is "perfect combustion," and, contrary to a view that has recently gained ground, it is further asserted that complete combustion is not only theoretically possible, but commercially practicable. It says:

"There are on the market to-day a number of complete combustion, or smokeless, furnaces. Some of these secure the requirements by mechanical stoking, others by using fire-brick arches or partitions, and others by forcing air into the furnaces with steam jets or by a combination of these systems. Each of these furnaces has given more or less satisfactory results in preventing smoke, the excellence of the result in every case depending upon the completeness with which the requirements of good combustion were satisfied. In justice to the consumers who must bear the expense of new furnaces, however, it must be said that it is not only a furnace which will prevent smoke that is wanted, but a furnace which will do it with the greatest economy, and here the problem begins to assume puzzling ramifications."

In the previous part of this article the term "complete combustion" having been used in the absolute sense, as implying the condition of smokeless combustion, the qualification "more or less satisfactory" in the last quotation seems at least a partial denial in one form of what has been asserted in another form. "More or less" is a very elastic expression. And the last sentence in the quotation is an implied admission that it is not easy to discern the commercially practicable in the theoretically possible.

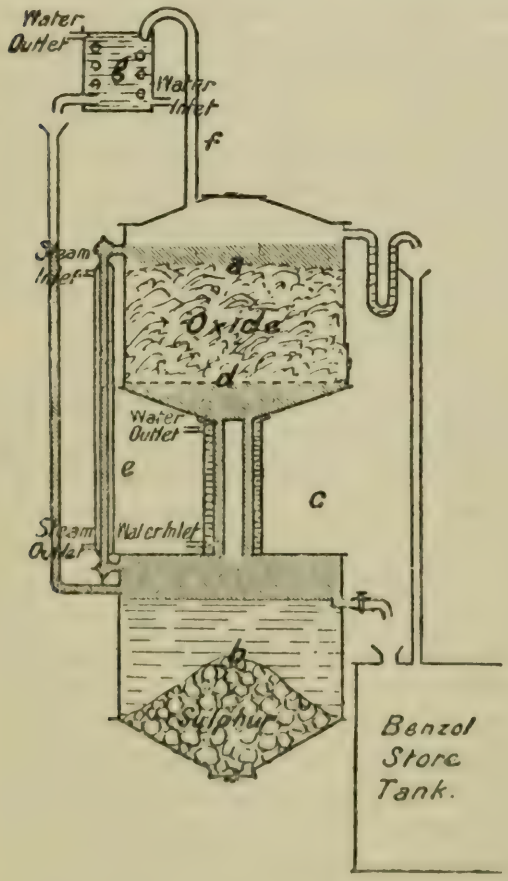
However, the writer holds it to be sufficient to say, in favor of his argument for the economy of smokeless combustion, "that mechanical stokers, or certain constructions of hand-stoked furnaces, can be had, which, in large plants, will economize enough in fuel alone to pay a fair return on the money invested in them. This is far from saying that all mechanical stokers, or all hand-stoked furnaces, are equally economical, or that either type is better than the other under all conditions.

"To sum up, smokeless combustion is merely a question of a properly-designed furnace and smoke-stack, and proper regulation of the supplies of fuel and air. Of course, to install a furnace which meets these requirements means an increased first cost over the installation of the brick box with a grate at the bottom which often passes as a furnace. It is a cost, however, which the public is justified in demanding to secure the single item of smokelessness, and, when, as a matter of fact, the saving in fuel and boiler repairs soon pays for the improvement, there should be no hesitancy in demanding it."

The third question is answered as only it could be logically answered. Given the right to demand the abatement of the smoke nuisance and the commercial possibility of avoiding its creation, its abatement should be made as compulsory as is that of any other abateable nuisance. If furnaces exist that will burn soft coal without smoke, the health departments of municipalities should have power to compel their substitution for the existing smoke belchers, and to prevent any further instalment of the latter in places where they can incommode citizens.

Cleansing Spent Oxid.

At a recent meeting of the Southern District Association of Gas Engineers and Managers (England) Mr. A. E. Broadberry outlined a method for removing sulphur from spent oxid in gas works, leaving the latter in good condition for use again. If this can be done at a cost within certain limits, it will be an important advance. Preparations to test the process in practical working are now in progress at Tottenham, Eng., preliminary experiments on a small scale having giving sufficient encouragement to warrant such a course. In this review we shall make a condensed abstract of Mr. Broadberry's paper, printed in the *Gas World* (Nov. 23), which will afford an idea of the nature of the process and of the apparatus. As the oxid was in no way prepared, but was treated in its normal condition, it may be relied on that the results could be reproduced on any larger scale.



The accompanying sectional drawing shows the arrangement of apparatus. Its simplicity is at once apparent. The upper or oxid vessel, *A*, is connected to the lower or sulphur vessel, *B*, by the water-jacketed pipe, *C*, with the filter or strainer, *D*, above it to prevent particles of oxid from passing down. A further connection between the two vessels is made by the steam-jacketed pipe, *E*. The ventilating pipe, *F*, is attached to a water-cooled condenser, *G*, the condensation being returned to the apparatus. Except for the stop-cocks for steam, water, etc., and the doors for charging and discharging, there is an entire absence of cocks, valves, or working parts to be manipulated. In fact, the process of working is as simple as the apparatus itself.

The oxid to be treated is placed in the upper chamber,—the lower one being about half filled with water,—and then benzol or similar solvent is put in up to about the overflow, entirely covering the oxid. To set the apparatus in operation, all that has to be done is to pass a small current of steam into the steam-jacket, and a flow of cold water through the water-jacket, and through the condenser. The heat communicated to the solvent in the pipe, *E*, induces an upward flow, and discharges it on the top of the oxid in a heated condition,—that is to say, at about 70° to 80° C. The return flow of the solvent is through the cooling pipe, C, which has its central portion occupied by a cylinder, the better to expose the solvent to the cooling surface; and this deprives it of its heat, returning it to the lower chamber at, say, about 25° C. The circulation thus produced continues automatically, so long as the steam and cold water are supplied to their respective places.

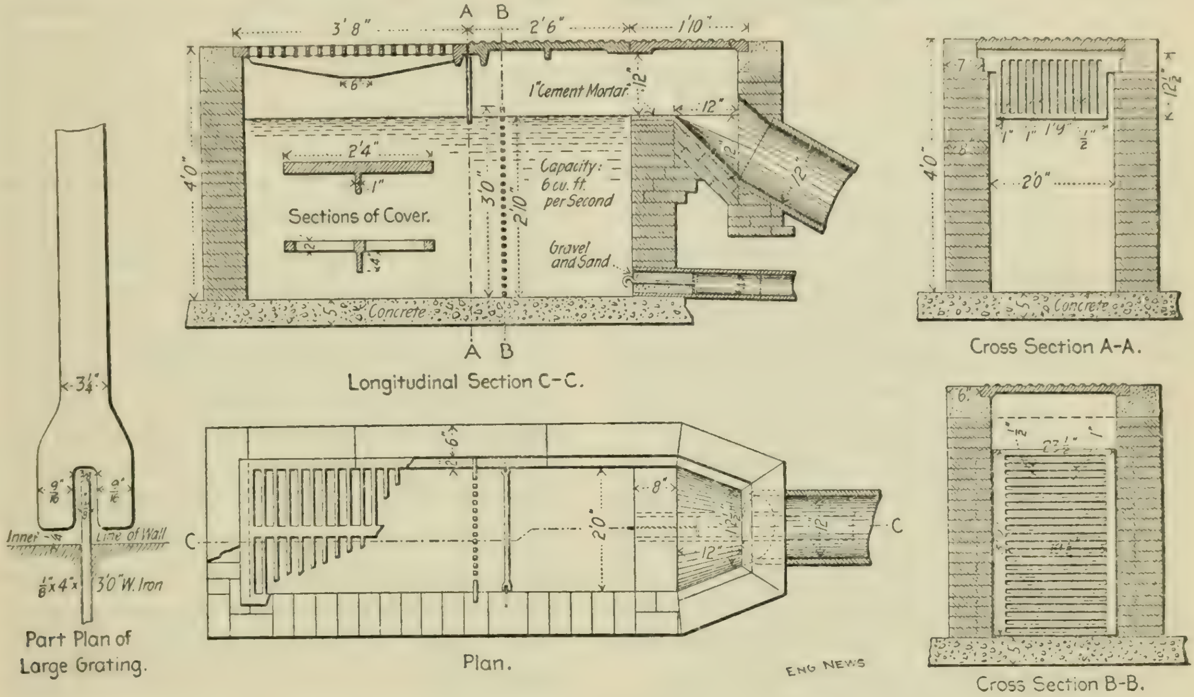
Benzol, at its temperature of 70° to 80° C. in the upper chamber, will dissolve 2½ to 2¾ lbs. of sulphur per gallon; but, when cooled to 25° C., on its return to the lower one, it will retain only ¼ lb. per gallon. Therefore it follows that for every gallon circulating, while there is plenty of sulphur in the oxid on which it can act, over 2 lbs. of sulphur are extracted from the oxid and deposited in the water at the bottom of the sulphur vessel. The principle of action is the differential absorption of sulphur by the solvent at varying temperatures. Having filled the apparatus with spent oxid, water, and solvent, and turned on the steam and water, the apparatus may be left to itself until the extraction has ceased, when the benzol is drawn off and the oxid thoroughly steamed to distil and recover the benzol with which it is saturated."

A calculation of cost, and of the value of the recovered oxid, by Mr. Broadberry, shows a net profit of 26s. 3d. per ton of spent oxid treated, which, if it can be realized on a large scale, will be a material economy in the gas industry.

Catchbasin for Large Flows.

PEORIA, Illinois, is acquiring a reputation for the high character of its municipal engineering work. It is believed to be the first municipality to establish and maintain a complete testing laboratory, and, in paving and sewer construction, it probably compares favorably with any city of its size in the world, and with many much larger cities.

A sample of the municipal work done in this enterprising town is presented in the accompanying engraving, reproduced with a description by W. C. Parmley from *Engineering News*.



DETAILS OF STANDARD CATCH BASIN PEORIA, ILL.

This catchbasin "was designed in 1893 to be used at points where water passes the common catchbasin, or where the volume of flow is unusually large.

"The inlet consists of a rectangular pit 2 × 6 ft. in size, with concrete bottom, brick walls, and cut-stone coping covered partially by perforated cast-iron covers, as shown. The inlet is set in the gutter, with the top of the plates depressed about two inches below the surface grade line. The water falls through the cover grate, and thence passes the two inner grates, shown in sections *B B* and *C C*.

"Most of the rubbish is thus removed, and the water discharged over the sill to a twelve-inch outlet pipe. This tile is partially choked by a gravel filter held in place by a perforated iron plate attached to a book-shaped iron handle. The filter can thus be easily removed and replaced whenever necessary.

"The accumulated rubbish may be removed after lifting the two inner gratings out of place, thus leaving a pit of convenient shape to be shoveled out.

"The inlet capacity is estimated at from twelve to fifteen cubic feet per second, with two inches of water over the grating, and the outlet capacity is estimated at six cubic feet, or about six times that of the ordinary catchbasin. On steep grades the coping stone at the upper end is omitted and the adjacent pavement depressed, leaving a clear passageway under the upper end of the cover grating.

"About a dozen of these catchbasins were built the past season, and they have proved very satisfactory. The cost, including sewer connection, is from $55 to $65 each. In some cases a smaller-sized inlet is used, which differs only in having a pit 2 × 4½ ft., a depth over discharge sill of 10 in., and a 10-in. outlet pipe, giving about 4 cu. ft. per sec. discharging capacity. The cost is thus reduced about $5."

Purification of Water by the Archbutt-Deeley Process.

THIS process, which has been for a considerable time in use for industrial purposes, as in dye-works, chemical manufacturing, and the preparation for use in steam-boilers of water charged with mineral impurities, will, it is announced, be now applied on a larger scale for the treatment of hard waters in municipal water works. The *modus operandi* and the *rationale* of the process are, therefore, subjects of current interest to municipal engineers. We present an abstract of a description given in *The British Architect* (Nov. 29), wherein the process, as applied to water for steam-boiler supply, is explained by an eye-witness. The essentials of the process are the same when it is used for purifying municipal water-supply.

The purifier consists of a cast-iron tank divided into two equal parts by a transverse partition. The two tanks thus formed are fitted up exactly in the same way, the processes of filling, softening, and clarifying being carried on in one, while softened and clarified water is being drawn off from the other. Hard water is admitted to either tank by means of a supply-pipe, which is connected up to a pump or main. The water is run in up to the level of a gage mark on the side of each tank. While the tank is filling, quicklime and sodium carbonate (58 per cent. ammonia alkali), in proportions which depend upon the character of the water, are weighed out, and boiled up with water in a small chemical tank by means of live steam. The lime is first slacked in the hot water, and then the alkali is added and stirred until dissolved.

When the tank is full and the inlet valve has been closed, steam from the boiler is admitted to the blower, causing a current of water to circulate. The prepared chemical solution is slowly drawn into the circulating current, and thus diffused throughout the body of water. Air is then admitted through a pipe at the top of the blower, and is made to stir up some of the precipitate or mud (from previous operations) which lies on the bottom of the tank. Before being mixed with this mud, the new precipitate, which is very finely divided, will not coagulate, and takes a long time to settle; but, when the old precipitate, consisting of coarse particles, is stirred up, the fine particles attach themselves to the coarse ones, and subsidence of the precipitate is thereby greatly accelerated when the water is allowed to rest.

After the blower has been in operation for fifteen minutes the steam is turned off, and it is claimed that in about thirty minutes, or from that to an hour, very nearly all the precipitate will have settled to the bottom of the tank, and the water, even down to a depth of 6 feet from the surface, will not contain an average of more than about one grain per gallon of suspended matter. The chemicals, however, have been added to the cold water, and it is found that, when such water has been softened and afterwards becomes raised in temperature in the hot pipes, injectors, &c., connected to boilers, a further slight precipitation occurs, which gradually forms a coating on the interior of the pipes. To prevent this the water is carbonated. This has the effect of rendering permanently soluble the trace of hardening matter retained by the water.

The largest quantity of water under treatment at present is at the locomotive works of the Midland Railway Company, at Derby, where a plant softening 30,000 gallons per hour has been in successful operation since 1891. The hardest water under treatment is at a mill in Nottingham; it has 35½ degrees of hardness, and contains both carbonate and sulphate of lime, as well as a large quantity of magnesium salts. By the treatment the hardness of the water is reduced to an average of 3.2 degrees, and the formation of scale is entirely prevented.

THE modern plumber, says *The Hospital*, is a kind of half sanitary engineer and half doctor. He must have such a knowledge of smells and tastes, with their good or evil effects upon the human organism, as the doctor possesses; and such a capacity for safely conveying away all waste and deleterious matter as the practical engineer can boast.

Thus educated and equipped, he can convert the most unwholesome of dwellings and public places into perfect arcadias for sweetness, provided you give him a plentiful supply of money. It is the worthy ambition of the Plumbers' Company of London so to utilize its funds—not very large funds, by the way—as to provide for every town or village in Great Britain as many thoroughly competent plumbers as the necessities of the country demand.

To secure the registration they ask for they require an act or acts of parliament; and everybody who has the least comprehension of the almost infinite importance of pure water, efficient drainage, and a sweet atmosphere must wish them success.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

3021. On the Poisonous Action of Acetylene. M. N. Grehant, in *Comptes Rendus* (Comparative experiments supporting the conclusion that illuminating gas is much more poisonous than acetylene). Elec Eng–Dec. 11. 800 w.

*3025. Tower Scrubbers and Horizontal or Washer Scrubbers. William Newbigging (Objections to tower scrubbers and suggestions for improvement, with discussion). Jour Gas Lgt–Dec. 3. 5400 w.

*3026. The Installation of Carburetted Water Gas at Blackburn. S. R. Ogden (An important paper giving tabulated statements of working, materials consumed, and results obtained, with discussion). Jour Gas Lgt–Dec. 3. 4500 w.

*3090. Gasholder without Columns (Illustrated description of the largest gasholder ever built without columns, erected at Middlesborough, England). Eng, Lond–Dec. 6. 1100 w.

*3435. Carburetted Water-Gas at Blackburn. S. R. Ogden (A very interesting and full account, with tabulated results of test runs, of a new plant erected at Blackburn, England, under such restrictions in the contract for its construction as would bring out any deficiency in the process, which, notwithstanding, demonstrated its efficiency completely). Gas Eng's Mag–Dec. 10. 2100 w.

*3468. Thoughts and Recollections—1895 (A review of the gas industry for the year, in which progress, though slow, has not been wanting). Gas Wld–Dec. 28. 7000 w.

*3469. New Gas Works at Sleaford (Illustrated detailed description). Gas Wld–Dec. 28. 1200 w.

Sewerage.

*3310. Sewage Treatment. Douglas Galton (Paper read before the Sanitary Institute. Gives an account of the Massachusetts experiments, and the conclusions to which they point, the object being to open a discussion of the subject by members of the institute). Ind & Ir–Dec. 20. Serial. 1st part. 2000 w.

3325. A 94-in. Sewer and Storm Overflow at Denver, Colo. (Illustrated detailed description). Eng News–Dec. 26. 1800 w.

3326. A Catch-basin for Large Flow, Peoria, Ill. W. C. Parmley (Illustrated detailed description of an interesting construction for an exceptionally large volume of flow). Eng News–Dec. 26. 300 w.

*3352. East Molesey Drainage and Sewage Disposal Works (Illustrated detailed description. Separate system adopted. Storm water excluded. Two-page inset. These works constitute a model plant in many respects). Engng–Dec. 20. 2000 w.

3420. The Sewerage and Subsoil Drainage System of Newton, Mass. G. M. Warren (Illustrated detailed description with diagram of average cost per foot of pipe sewage, map, profile, etc., with two page inset). Eng News–Jan. 2. 4000 w.

3422. Sewage Purification at Pawtucket, R. I. George A. Carpenter (Illustrated detailed description giving plan of sewage, filter beds, and settling tanks, etc.). Eng News–Jan. 2. 1700 w.

Streets and Pavements.

3217. An Inequitable Proposal for Disposing of the Street Sweepings of New York (An editorial criticism of the conditions named by the street cleaning department, under which proposals for the final disposition of street sweepings, ashes and other refuse collected in New York City were invited, and which failed to draw out proposals. It is shown that, under the conditions specified, proposals could not reasonably have been expected). Eng Rec–Dec. 21. 2000 w.

*3224 About Paving Materials (A consideration of the wearing qualities and general excellence of various kinds of materials, concluding that the experimental stage is not yet passed). Can Arch & Build–Dec. 1000 w.

*3405. Standard Specifications and Methods of Testing Paving Brick (Report of Edward Orton, Jr., secretary of the commission on standard specifications, appointed by the National Brick Mfr's. Assn.). Pav & Mun Eng–Jan. 3800 w.

Water Supply.

*3004. Locating a Public Water Supply. Daniel W. Mead (Showing how topographical, hydrological, and hydro-geological conditions affect the choice of a source of water for public use). Eng Mag–Feb. 3500 w.

*3094. Water Purification and Softening by the Archbutt-Deeley Process (Illustrated description of apparatus and process, and an account of a public test made to demonstrate the value of the process, and its practicability for large quantities of water for town use). Ry Wld–Dec. 1200 w.

3179. A Simple Apparatus for Collecting Samples of Water at Various Depths. Ill. George Chandler Whipple (Descriptive). Science–Dec. 20. 800 w.

3218. Water-Works for Small Cities and Towns (First part is introductory and treats of surveying watersheds, run off from watersheds, minimum run off, storage capacity required, gauging small streams, and meaning of chemical analysis. Three tables are also given: (1) showing the amount of storage required to make available different daily volumes of water per sq. in. of watershed; (2) discharge of weir 1 ft. long; (3) water analyses). Eng Rec–Dec. 21. Serial. 1st part. 4800 w.

3278.—75 cts. Uniformity of Methods in Testing Water Meters. Ill. John Thompson. with Discussion (Affirms that it is time water meters should be tested by uniform methods, and sets forth particulars in which uniformity should be attempted. It also describes an apparatus and a method for the more accurate testing of meters). Jour N Eng Water Works Assn–Dec. 10500 w.

3280.—75 cts. The Metropolitan Water Supply of Massachusetts. Albert F. Noyes (A general synopsis of the work done and in progress for obtaining water supply for the metropolitan district of Boston. Discussion). Jour of N Eng Water Works-Dec 3000 w.

*3345. The Chemical and Biological Examination of Potable Waters. Edward F. Willoughby (Abstract of a paper read at the meeting of the Sanitary Assurance Association. The subject is treated from only two standpoints, namely, the ascertaining of the fitness of water for drinking and its qualities for other domestic uses. The examination discussed, therefore, differs materially from an exhaustive chemical analysis of mineral water, and includes the use of the microscope as well as chemical tests for nitrogen, etc). San Rec–Dec. 20. Serial. 1st part. 1400 w.

*3358. Water Supply, Past and Present (Interesting historical account, touching on its combination with architecture). Ill Car & Build–Dec. 20. 1600 w.

3531. Experimental Water Filter Tank at Pittsburgh, Pa. (Illustrated detailed description. The tank is built of "Cementine," a combination of metal lath and cement). Eng News–Dec. 12. 1500 w.

Miscellany.

†3015. Municipal Fire Insurance. Robert Donald (The broadest paternalism is advocated. The article supports the general thesis that "there can be no finality to such expansion of duties as fall to public authorities; and then proceeds to discuss alleged advantages which would result from municipal fire insurance). Contemporary Rev–Dec. 6200 w.

*3040. Description of the Shoreditch Refuse Destructor Works. G. Manville (With an introductory consideration of principles involved). Ind & Ir–Nov. 29 4500 w.

*3084. The Cost of Lighting by Gas and by Electricity. A. P. Trotter (A comparison attempted but considered impossible without further data, but concluding that if the two systems were placed on equal conditions, the cost of gas lighting would largely exceed that of the contract for electric light). Elect'n–Dec. 6. 3000 w.

*3106. Practical Disinfection. Edward F. Willoughby (Unsatisfactory work of municipal authorities alleged, and suggestions for improved methods). San Rec–Dec. 6. Serial. 1st part. 1300 w.

*3119. Electrolysis Prevention at Newark, New Jersey. Harold P. Brown (Description of a method of making a thorough examination of the water and gas pipes). St Ry Rev–Dec. 15. 3800 w.

3138. Municipal Art (Editorial discussion regarding the proper site for the memorial to be erected to the soldiers and sailors of the War for the Union). Gar & For–Dec. 18. 1200 w.

*3196. The Paris Municipality and Electric Installations (Editorial consideration of the rules referring to electric power stations and distribution of the current in Paris, with general summary of the restrictions placed upon industrial companies). Engng–Dec. 13. 3900 w.

3279.—75 cts. Tests of Articles of Commerce, to be Conducted by the Association. Clemens Herschel (A proposition that the Association shall cause tests of articles used in waterworks installments at the expense of the Association. Discussion). Jour of N Eng Water Works Assn–Dec. 3500 w.

*3404. A Municipal Testing Laboratory. Ill. A. D. Thompson (Illustrated description of what is believed to be the first complete testing laboratory yet established. It is at Peoria, Ill.). Pav & Mun Eng–Jan. 2000 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

Discipline Without Suspension.

THE dissatisfaction among railway employees during the past few years has had such an undesirable effect upon our industries, and destroyed the *entente cordiale* among railway men to such an extent, that any remedy proposed is very welcome.

Locomotive Engineering (Jan.) contains a second article by Mr. Geo. R. Brown, the general superintendent of the Fall Brook Railway, on the methods employed on that road to discipline their employees:

"The usual penalty for a serious violation of rules on American railroads is dismissal from the service. Minor infractions are usually punished by depriving the offender of employment for a fixed time,—ten, thirty, or sixty days; a few roads have adopted the European practice of direct fines. In my estimation, as a rule, these forms of punishment are unjust and inhuman, as a law cannot be effective without a penalty. Penalties are imposed for two purposes: first, to uphold the law and prevent its further violation, and, second, to reform the violator."

"Suspending sentence" is better than immediate punishment, as there are few men who make no mistakes, and we learn best how not to do by means of the errors we make. Every wreck, every accident, every mistake, every loss, has taught its lesson, and these are of no less value to the railroads and to railroad men than the successes. I practise making every mishap a lesson to every man on the road.

"In order to make every accident and incident happening on the road a lesson to all the train men, I established twelve years ago a Miscellaneous Bulletin Board. On this we post up brief accounts of the mishaps and other occurrences on the line, pointing out how such trouble could be avoided, etc. This board is closely scrutinized. We do not mention names, but of course, the men know 'who's who' in most cases. To show the class of notices posted, I inclose a few that have appeared. We usually have a notice up ten days:

"I regret to announce that thirteen out of forty-six freight- and coal-train conductors who have worked the full year ending with May 31, 1895, have lost their $60 premium. Last year there were but three out of forty-seven who lost it.

"We believe it is possible, and we hope that the coming year every conductor in the employ of the company will be entitled to this premium, ending with May 31, 1896.

"Please remember that it remains entirely with yourselves whether you get it or not. The original notice stated that your services must be entirely satisfactory for the full year in order to ensure it. Please make diligent effort, each and every one of you, to procure this $60 with your May pay for 1896.

"Caboose No. 27 had to have a new set of springs put under it, on account of being loaded too heavy with links, pins, etc. There was taken out of this caboose 2,020 pounds of unnecessary material.

"Conductors will only allow such material in their cabooses as may be actually necessary, and not load the boxes down for the purpose of making the springs ride easier; and it is unnecessary to haul a ton of this material around month after month.

"I understand that recently, at a night telegraph office, the semaphore light had gone out and the blade was wrong when a train arrived at the station. This was not reported to Corning office by the train so finding it, and should have been done from the next telegraph station. All conductors and engineers will please report any violations of this kind at once.

"Please remember that employees' lives are jeopardized when operators do not strictly comply with rules and regulations, and parties who know and do not report these things will be considered as guilty of negligence as the operators themselves.

"We also pay premiums to section foremen for the best-kept track. Three premiums on each division, $40, $20, and $10 respectively. The benefits derived are even more than expected. The condition of the track is at least twenty-five per cent. better, and the track pay-rolls for the year ending October 31, 1893, was $37,199.66, and for the year of 1894 $41,842.46 less than the average for the eight years before premiums were given.

"For the trainmen we keep a record

book. This book is never shown to any employee, except that page which is his personal record.

"In it I write down a brief statement of every irregularity for which a man is responsible; this record takes the place of the 'lay off,' and is dreaded fully as much; the man goes to work at once, and no one but himself suffers, and he only in reputation at headquarters.

"We are very careful in the selection of our men; promote all our own engineers and conductors; and in a few months or a year or two our record tells us whether they are adapted to the business or not. We have engineers who have been running here more than twenty-five years without a scratch of the pen against them; while others, who have been running as many months, have quite a page full of irregular circumstances; but down near the bottom of such a page can generally be found the words 'Discharged—incompetent.'

"It is well understood that we do not wish to retain in the service men who deliberately deceive us about mishaps on the road; we want the 'straight' of every matter, and we want it at first hands. It would be a very lively detective who could get to my office sooner than some of the men who are responsible for the accidents. If it is not serious enough for dismissal, the matter is overlooked or made a matter of record, and the man goes out on his regular run. Then the 'Miscellaneous Board' has another object lesson on it.

"If there is anything that will stimulate a good man, who has become careless enough to make a lapse of duty that 'gets him in the book,' more than that simple record, I do not know what it is. It is a mistake to disgrace an employee before his fellows, as it is liable to make him revengeful and cause him to lose interest in the success of his work. A competent man will endeavor to keep a clear record, and all others had better be gotten rid of for the good of the company. The Pennsylvania Steel Co. employs a similar system.

"On many roads there is a great want of cordiality or confidence between the men and the officials immediately over them. In too many cases a suggestion from a trainman to an officer would be resented as an unwarranted interference. It seems to me this is not in the interest of the railroad company, however much it may enhance the dignity of the official,—who is himself 'only one of the hired hands,' with a little more responsibility.

"I have found suggestions from the men of vital importance in matters of detail, and every man in the service knows that the rule and motto at headquarters is, 'Suggestions are always in order.'"

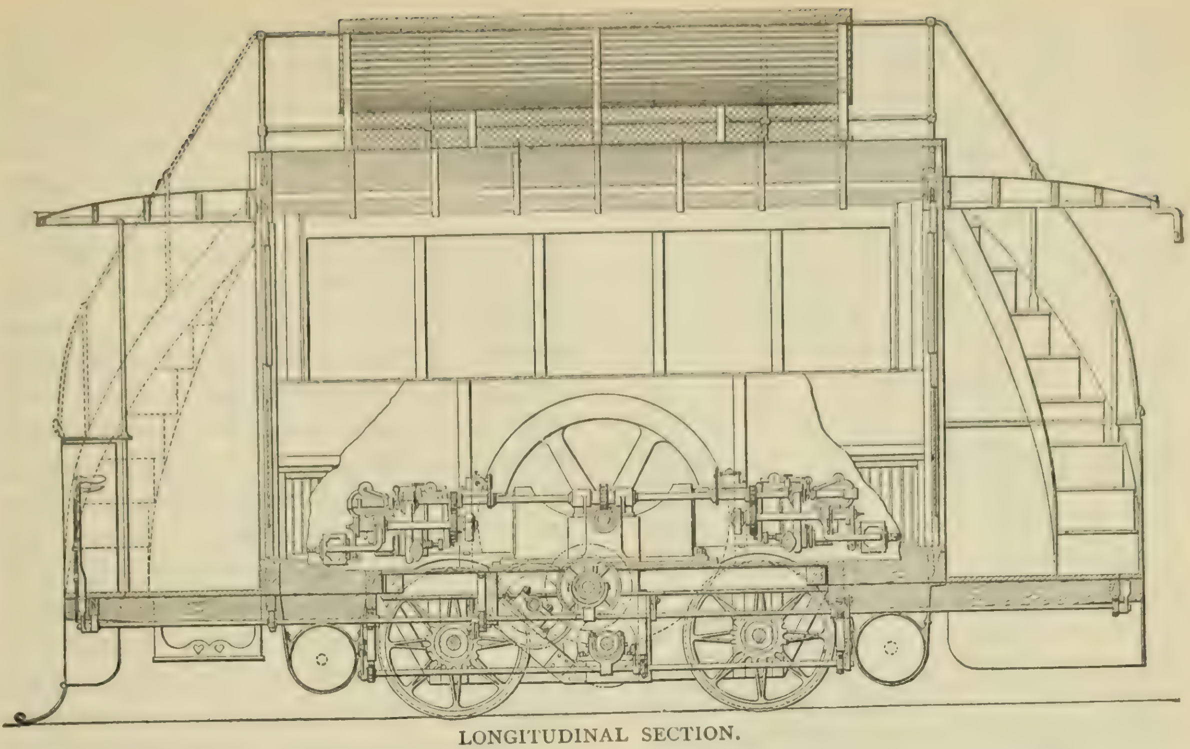
The author commends the system very highly, and says: "It has worked so well for years that I have an abiding faith that it will work anywhere, and in every case in the interest of better service."

Gas Traction for Tramways.

In our issue of last November, under the title "Gas Street Railway in Dessau," will be found a description, with data, of the operation of this unique passenger line. We now give some further particulars, with a cut illustrating the method of construction of the car and driving mechanism, taken from the *Journal of Gas Lighting* (Dec. 10). The installation is described as follows:

"Gas-motor cars, built on the Lührig system, have been in successful operation in Dresden since July last year; and the results have been such as to lead to the equipment of a line in Dessau worked entirely by means of gas cars. Coming nearer home, Lührig cars were about the same time placed upon the line running between Thornton Heath and Croydon, England.

"The accompanying illustrations represent a sectional elevation and a cross section of a gas-motor car. It will be seen that it is self-contained, and of the ordinary type, with 'garden' seats on the top. All the machinery is enclosed and concealed from sight; it is cleanly in working, and does not cause nuisance by vibration, heat, or smell. The motor is a double-cylinder gas-engine of the 'Otto' model, so arranged that all parts can be easily reached.

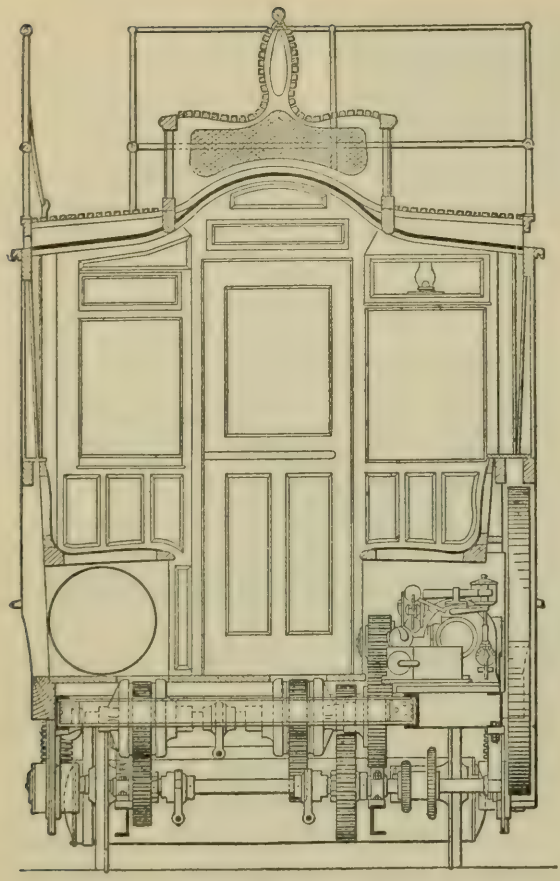


LONGITUDINAL SECTION.

While on the road, the engine is completely under the control of the driver, who can reverse the car or reduce the speed at will. The gas is taken from the mains supplying the town, compressed to about 120 lbs. per square inch, and then delivered by an ordinary india-rubber tube to the car, where it is stored in reservoirs carried underneath, containing, when fully charged, about 300 cubic feet, or sufficient gas to enable the car to travel about eight miles without any risk of the store being exhausted during the journey. The refilling of the reservoirs usually takes about a minute and a half; and this can be done at the starting-place, or at any convenient point on the road where a compressing plant can be erected. This plant is of a very simple and inexpensive character, and no noise, soot, or smoke is produced by it. At Dessau the compressing station is only in use for three hours a day; and a compressor driven by an 8-horse power engine suffices to work twenty cars continuously. On the introduction of gas-driven tramcars in Dresden and Dessau, questions were raised in certain quarters as to a possible danger to the public from storage of compressed gas, and fears were entertained that explosions would result. Of course, these proved to be groundless. There is no light of any kind upon the car, the ignition necessary for starting the gas-engine being done electrically.

"At Dresden, the line is not quite three miles long, with easy gradients. The cars carry about twenty-five passengers, and they run at the rate of 7.2 miles an hour, including stoppages. The total quantity of gas paid for in the first half of the present year, for all the purposes of the line, was 36.8 cubic feet per car-mile, the cost of which, at 2s. 6d. per 1,000 cubic feet, would be 1.23d. But even these low figures must not be taken as representing the best that can be done. At Dessau the length of the two lines in use is not quite three miles each; and the gradients are not heavy, the cars taking them without reduction of speed. The curves, however, are trying. The total quantity of gas used in the four months ending April last (in which period the cars had run 54,500 car-miles, and carried 196,460 passengers) was 29.8 cubic feet per car-mile, which, at the above-named rate, would work out to just under 0.9d. per car-mile, instead of 1.23d. as at Dresden. At Dessau, the cars actually run about five miles per charge of gas; but this distance could well be increased."

Some idea of the cost of running may be obtained from the cost at Croydon, England. The gas is there procured at 2s. 10d.



CROSS SECTION.

per 1,000 cu. ft., making the running expenses "less than 1d. per mile run, as compared with 2½d. for electricity on the trolley wire system, or 5d. for horse traction." Mr. Corbet Woodall, a prominent engineer, thinks no other power for tramcar traction can be provided at so low a cost as gas, and with so few objectionable features.

Tramway Motive Power.

THE question of relative economy is the primary one which determines what system of propulsion shall be used on any road. The secondary questions of speed, comfort, noise, safety, etc., apply to all systems, whether horses, steam, cable, compressed air, oil engines, gas engines, water jet, electricity, or any other means constitute the moving power. In *The Practical Engineer* (Nov. 15) an article is condensed from the *Pall Mall Gazette* on the various systems employed in England. Speaking of steam and horse traction, it says: "On the basis of financial results there is little to choose between horses and steam as the motive power for tramways. Steam has, indeed, a number of objectionable features which must debar it from ever making very great headway and it is pretty generally recognized that it is no more the ideal force for tramway propulsion than horse traction. . . . . Compressed air motors have been tried, and in France it has met with a certain degree of success; but in London they failed utterly, by reason chiefly of the heavy cost of operation. Oil motors have also been tried; and there is one company in London prepared to supply trains worked by gas. Oil is so far only in the experimental stage, and may be left out of count. The present tendency is very markedly in favor of either electric traction or cable haulage. The first of these is being more generally applied by means of overhead wire conductors fixed in position over the tracks in the streets. . . . The other method of electric traction is worked by conducting the wires in a conduit under the tramway track. This conduit system is followed at Blackpool and Budapesth. It is open to more objection on the score of danger than the overhead system, the great objection to which is the unsightliness of the posts and wires. Birmingham enables us to compare the various methods, as it has the four principal systems at work,—horse, steam, electricity, and cables,—and the following table will give a good notion of the relative profit in that city. The figures are for the last available year:

	Miles run by cars.	Average receipts per mile run.	Expenses per mile run	Net profits per mile run.
		Pence.	Pence.	Pence.
Steam...	1,225 996	15.99	11.22	4.77
Horse...	647,652	10.93	10.12	.81
Cable....	641,161	12.69	6.32	6.37
Electric..	140,993	16.38	16.55	.17 (loss)
Aver's.	—	13.99	11.05	2.94

Some Notable English Engines.

AMONG the noteworthy features of our modern locomotive construction is the apparent unnecessary height of boiler above the driving axle. This was not always thus, and the present development from low boilers is shown in an interesting article in *The Railroad Gazette* (Nov. 15), which begins as follows:

"It is not the object of the present

article to deal with ancient locomotives, but those belonging to what may be called the medieval period of railroad history, when the early engines were found to be unequal to the enormous increase of traffic during that time.

"The life of a locomotive superintendent in those days was certainly not a happy one, for, in addition to the numerous difficulties and responsibilities of his office, he had to solve the problem of designing powerful economical engines to run on iron rails weighing from 44 to 75 lbs. to the yard. He was between two fires: on the one hand, his directors were ordering him to build new engines to draw heavier trains at increased speed, and, on the other, the engineer of roadway was complaining that the ponderous locomotives were battering out the rails. Then again, he always had to face the periodical grumble that his engines were burning too much coal.

"There was also another obstacle to his progress, which, remarkable as it may seem, was an imaginary one. For many years it had been an established theory, beyond question, that the boiler of a locomotive should be kept as near to the rails as possible, to ensure steadiness and safety at high speeds. In order to meet this supposed requirement and at the same time to employ large driving wheels, engineers spent a great amount of time and energy in building a variety of experimental and costly machines, some having the driving wheels and motion on a separate frame from the boiler, and others having the driving axles placed through the firebox and smokebox by means of water bridges, with fearful and wonderful arrangements of bell crank levers and rocking shafts between the cylinders and driving wheels. One of these 'mills' seen by the writer never even traveled on rails, but, after being jacked up clear of the ground and tried under steam, was laid aside as useless. Perhaps the most widely known example of the 'low boiler' theory was Francis Trevithick's 'Cornwall,' built in 1847 for the London & North Western; having the driving axle *above* the boiler and the boiler center only 2 ft. 8 in. from the rails. With such an engine before us as the New York Central '999,' having the boiler center 8 ft. 11½ in. from the rails, it is difficult to understand why such a fallacy as 'low boilers' should have occupied the minds of practical men for so many years; but such is the fact."

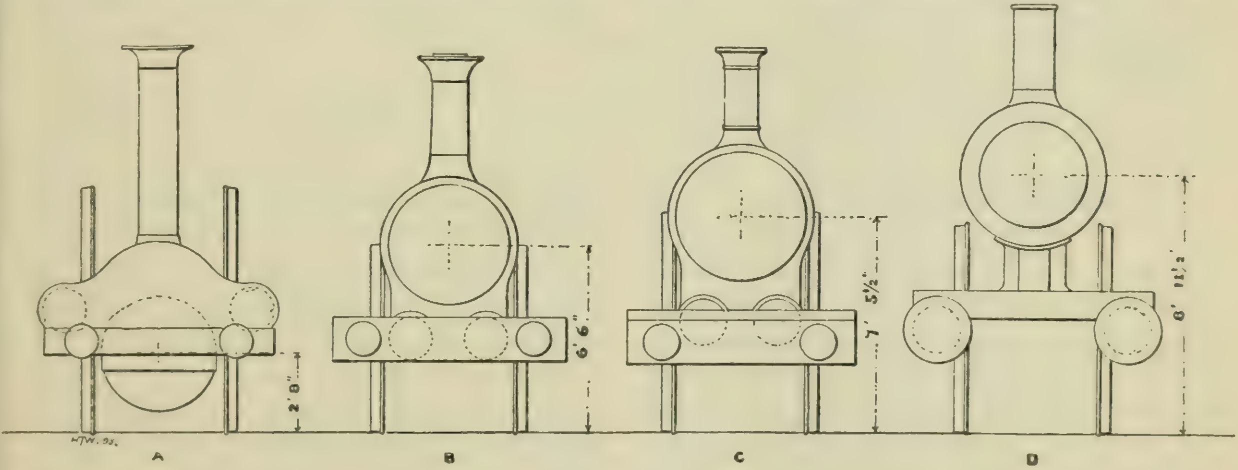


Fig. 6.—Comparative Heights

The editor then describes a number of types of locomotives covering a period limited by the years 1840 and 1870, and concludes:

"All the foregoing engines were able to draw their trains at average speeds which will compare favorably with those of the present day. They were of the highest finish, and shone like glass; the boilers and wheels were painted a bright green, the frames a dark red; the steam dome and safety-valve covers were of polished brass, with sometimes a polished copper cap to the chimney.

"A diagram (Fig. 6) is given for the purpose of comparing the heights of some of the engines under notice,—namely, *A*, Trevithick's L. & N. W. engine Cornwall; *B*, average height of express engines of the period; *C*, McConnell's L. & N. W. engine 373; *D*, Buchanan's New York Central engine 999."

Comparison of Compound and Simple Locomotives.

As the result of a series of observations on the Chesapeake and Ohio Railway, *The Railroad Gazette* (Nov. 22 and Dec. 6) publishes tables showing a saving by the compound over the simple locomotive of about 400 tons of coal per annum in the first case, and at the rate of 500 tons per annum during the month of August, 1895.

COMPARATIVE PERFORMANCE OF SIMPLE RICHMOND ENGINES AND RICHMOND COMPOUND, IN SERVICE ON THE CHESAPEAKE & OHIO RAILWAY.

Engine number.	Engine mileage.	Loaded freight car mileage.	Cost of repairs.	Repairs per 100 miles run.	Tons of coal used.	Miles per ton of coal.	Average cars in train.	Pounds coal per Eng. mile.	Pounds coal per car mile.
Average of 10 simples......	70,066	2,350,281	$2 194.24	$3.13	4,593	15.25	37.5	131	3.91
Compound No. 140.	85,236	2,891,793	2,441.70	2.88	4,262	20.00	38.7	100	2.95
In favor of compound for two years to Dec., 1894				7.9%	......	31.13%	3.5%	23.7%	24.5%

C., C., C. & ST. L. RY.—12 SIMPLE ENGINES AND RICHMOND COMPOUND NO. 472. AUGUST, 1895.

Engine number.	Size of cylinders.	Miles runs.	Pounds coal consumed.	Miles run to 1 ton coal.	Number loaded cars hauled 1 mile to ton coal.	Pounds coal per loaded car hauled 1 mile.	Number loaded cars per train.
Average 12 simple engines...	19 in. × 24 in.	3,464	316,333	21.90	505.4	3.96	23.1
Compound No 472...........	19 in. & 30 in. × 24 in.	3,061	208,000	29.43	691.6	2.89	23.5
In favor of Richmond compound No. 472, for August, 1895...				34.3%	36.8%	27%	1.73%

Light Railways in Hungary.

Owing to the interest manifested in England in "farmers' railways," the foreign office has issued a circular to its representatives on the continent requesting information on light railways in use in the countries in which they reside. The first report comes from Hungary, where the zone system is very fully developed. "In the year 1892 there were sixty secondary railways in Hungary, of a total length of 3,722 kilometers, the ordinary gage being 1.435 meters and the narrow gage 0.76 meters. The capital necessary for their construction has, as a rule, been obtained by private enterprise, to which the State, the municipalities, the parishes, and others have contributed, either in fixed amounts, in subsidies, or by offering some guarantee, according to their interest in the railway to be constructed. The State also remunerates such railways for carrying the mails, either by yearly payments of certain amount in proportion to the services actually rendered, or by arranging an annual sum payable for a certain series of years. There are also instances of municipalities guaranteeing the yearly payment of interest, and the quota of amortization of the debentures issued by such railways. At the same time it must be mentioned that these shares are, for the greatest part, held by the contributors, who have the greatest economical interest in the construction of the lines, owing to the facilities of communication thereby obtained, and to the consequent increase in the value of their estates. As to the State contributions, they are counterbalanced by the increase of the traffic of their own lines, as well as by the general economic development to be expected in the districts through which the secondary lines pass.

"As a matter of fact, only eight out of the sixty secondary railways have paid dividends on their ordinary shares up to the year 1892. In that year their income in proportion to their actual capital was 3.45 per cent., or, in proportion to the nominal capital, excluding the ordinary shares, was 4.61 per cent. The percentage of the deficit, without reckoning the ordinary shares and only taking into consideration the sums required to meet the interest and the quota of amortization, in 1892 was 11.09 per cent. The receipts in 1892 were: per passenger, 1.70 kreuzer about $\frac{8}{10}$d) per kilometer, and on goods per ton 3.62 kreuzer (about $\frac{7}{10}$d.). The conclusion of the report on these railways in Hungary is of a very important nature, for it states that whether, and to what degree, they have stimulated the production and sale of dairy products, eggs, fruit, and vegetables, and products of other small industries in the districts through which they pass, cannot be ascertained. Without such information the rest of the report is of little value." These facts are of interest, not only to English promoters, but also to those considering similar projects in the United States, where population is much more thinly distributed than in Hungary.

THE RAILWAY AGE (Jan. 17) reports the cost of operating of the Chicago City Ry. Co., as follows in cents:

	1895.	1894.
Cable lines	10,240	9,972
Horse car lines	30,550	25,393
Electric lines	14,776	16,904
All lines	12,796	13,487

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

*3008. Railroad Accident and Emergency Service. W. L. Derr (Detailing the duties devolving upon, and the qualities requisite in, a railroad wrecking crew, and describing a wrecking equipment and its uses). Eng Mag-Feb. 4200 w.

3022. Functional Equivalents versus Mechanical Equivalents (Commenting upon the recent air brake decision the editor says that it is an application of the idea that in determining questions of patent infringement, functional equivalents deserve prior consideration over mechanical equivalents). R R Car Jour-Dec. 1200 w.

3023. Making Supplies in Railroad Shops (The editor contends that there can be no general decision as to whether railways should make their own supplies and repairs, as it depends upon other contributory circumstances than that of time or economy). R R Car Jour-Dec. 1500 w.

3024. The Revision of the M. C. B. Rules of Interchange. George S. Hodgins (Suggestions and observations on the rules governing the interchanging of cars, traffic and repairs on connecting railroads). R R Car Jour-Dec. 2000 w.

3037. Railway Signaling. W. McC. Grafton (From the Bulletin of the University of Wisconsin, No. 6. The article is prepared by the signal engineer of the Pennsylvania lines west of Pittsburg). Sci Am Sup-Dec. 14. Serial. 1st part. 3000 w.

†3038. Steam Heat on Passenger Equipment (A communication on the use of steam heat and the advisability of using a steam trap. A lengthy and interesting discussion followed the reading). Cent Ry Club-Nov. 9400 w.

*3039. The Electric Lighting of Railway Carriages. Ill. (A device consisting of dynamo and accumulator run from car axle. The advantages are stated and a trial described). Ind &Ir-Nov. 29. 3000 w.

*3082. Railway Train Lighting (Favoring electric lighting and describing a system by which each coach is self-contained, having each a small set of accumulators). Elec Rev-Dec. 6. 1600 w.

*3093. An Electro-Magnetic Tramway System (A new device using neither trolley nor subway connections. An illustrated description of a trial line in Philadelphia, Penna.). Ry Wld-Dec. 1800 w.

*3095. The Modern Application of Electricity to Traction Purposes. Philip Dawson (A paper read at the British Asso. An exhaustive article prepared with care and containing valuable statistics). Ry Wld-Dec. 4500 w.

*3101. Light Railways (An editorial dealing with the questions of government aid, gauge, rates, etc., anticipating a report to be issued by one of the two light railway associations just formed). Engng-Dec. 6. 2500 w.

*3120. Possibilities of Long Distance Transmission from Electric Railway Steam Plants (The opinion is expressed that the present methods must change very radically, if a central power station is to possess any advantage over auxiliary stations). St Ry Rev-Dec. 15. 1400 w.

*3121. Track and Overhead Department Economics. J. W. Greer (The advantage of the T rail and the best method of laying track is discussed). St Ry Rev-Dec. 15. Serial. 1st part. 3000 w.

*3122. The Galt, Preston and Hespeler Street Railway and Its Freight Service. Ill. W. H. Lutz (Description of a Canadian line with combined passenger and freight service. The freight department is quite successful). St Ry Rev-Dec. 15. 1400 w.

*3123. Examination Questions for Motormen and Conductors (The questions are given in full, 26 for the conductor, and 37 for the motorman, as asked by the Oakland Consolidated Street Railway). St Ry Rev–Dec. 15. 1500 w.

3132. The Trolley Opinion (Opinion of Judge Townsend in the case of Thomson-Houston Electric Company vs. The Winchester Avenue Railway Company. An important decision affecting the electric railway industry). Elec Ry Gaz–Dec. 14. 3500 w.

3139. Railroad Racing (Editorial. In considering the qualifications of locomotives for high speed performances, the essentials discussed are,—sufficient adhesion of wheels; adequate steam supply; and driving mechanism). Am Eng & R R Jour–Dec. 12. 2200 w.

3140. Some Difficulties of Electrical Railroading (The difficulties encountered in applying motors to car axles, the disadvantage of two motors, and stating that 30% of the power is consumed by the gears). Am Eng & R R Jour –Dec. 12. 2000 w.

3141. Description of a Locomotive Depot for the Accommodation of 180 Engines and Tenders. W. G. Scott (Paper read before the Liverpool Engng. Soc. The shed contains 30 lines of rails, each holding six engines. The principal features are briefly described). Am Eng & R R Jour–Dec. 12. 1600 w.

3147. The Annual Cost of a Freight Car to its Owner. Edmond Gardley, in *Equipment Guide* (The annual charge against box cars is calculated at $83; against gondolas $74.70). R R Gaz–Dec. 20. 1800 w.

3148. Notes on English Railroads. J. W. Thomas, Jr. (Permanent way, carriages, wagons, locomotives, signals, etc., are described as they are applied in England. The article is both interesting and detailed). R R Gaz–Dec. 20. 3000 w.

3177. Automatic Switch Indicators. W. W. Salmon (Paper read before the Railway Signaling Club. Description of various installations). Eng News–Dec. 19. 1800 w.

*3206. The Midland Railway Company's Locomotive Works at Derby (A very well illustrated description of works originating in 1844 and now covering 166 acres of ground, of which 44 acres are occupied by buildings). Eng, Lond –Dec. 13. 12000 w.

*3215. Gas Traction for Tramways (Illustrated description of a gas motor mechanism for driving street cars at Dessau). Jour Gas Lgt–Dec. 10. 1000 w.

3223. The Reading Plan at Last (A radical departure in railroad organization, which is expected to place the Reading Railroad on a solvent basis). Bradstreet's–Dec. 21. 1400 w.

3226. Underground London. From *Chambers' Journal* (An article considering in general the rapid improvement of traveling facilities, and specially the Central London Electric Railway about to be built). Am Arch–Dec. 21. 1600 w.

3237. Freight Car Doors (Discussion before the Western Railway Club upon the qualities requisite for good freight car doors). Ry Rev–Dec. 21. 3200 w.

3241. The Remodeled Shops of the Fitchburg Railroad at Keene, N. H. (A plan of the new arrangement is given, with description). Ry Age Dec. 20. 700 w.

3242. Economy in the Selection, Use, and Renewal of Cross-Ties. H. G. Hetzler (A first prize paper, from the Roadmasters' Assn. The paper is thorough and practical). Ry Age–Dec. 20. 3300 w.

3243. The Hanging of Brake Beams. Ill. (An equalizing device to prevent the tilting forward tendency of trucks. The device is in use on the D. & H. C. Co.'s lines). Ry Age–Dec. 20. 700 w.

*3257. The New Railway to Astrakhan (Advantages presented with reasons for the necessity of the line. The two routes discussed). Bd of Tr Jour–Dec. 900 w.

3291. Tests of Gas and Lamps for Car Lighting (A report by Professors Chandler and Denton on tests with both Pintsch and city gas in Argand lamps of the Pintsch and Gordon-Mitchell types. The tests were made for the Lehigh Valley Railroad). R R Gaz–Dec. 27. 1700 w.

3299. Improved Mail Cars. Ill. (Description of some new wreck-proof and robber-proof mail cars. They are without platforms, close coupled, very strongly framed, doors and roof protected by iron plates, and are brilliantly lighted by gas and oil). Business–Dec. 1000 w.

3321. Recent Designs in Metal Fences for Railways (An illustrated description of some cheap wire fences with iron posts). Eng News –Dec. 26. 1200 w.

3327. Railway Construction in 1895 (Statistics, by years and by states, of mileage built). Ry Age–Dec. 27. 400 w.

3328. Wooden Cross Ties. H. W. Church (Second prize paper on the best practice in selecting, laying, removing and adjusting railway ties). Ry Age–Dec. 26. 1700 w.

*3329. Reconstruction of the Car Ferry Transfer Aprons at Port Costa and Benicia. John B. Leonard (An apron connecting the transfer boat with the R. R. tracks. It consists of five longitudinal bowstring trusses 100 ft. long It is 44½ ft. wide and carries four tracks. Detail drawings are given). Jour of Assn of Eng Soc–Nov. 2500 w.

*3409. Discipline Without Suspension. George R. Brown (An excellent system of rewards for good work by employees and the effects of the system. Should be read by every superintendent). Loc Engng–Jan. 4800 w.

*3410. The Northwestern's Locomotive Testing Machine (A device for testing the efficiency of engines after coming from the shop, with the idea of improving on possible defects). Loc Engng–Jan. 1200 w.

*3418. Construction and Maintenance of Railway Car Equipment. Ill. Oscar Antz (An extended description of each part in detail). Am Eng & R R Jour–Jan. Serial. 1st part. 3000 w.

*3419. Passenger Train Detentions (Editorial. An examination into the causes). Am Eng & R R Jour–Jan. 1300 w.

3424. Railroad Travelling in Spain. S. W.

D. (An entertaining letter to the editor, giving many details of operation of the roads through this interesting country). R R Gaz–Jan. 3. 2500 w.

3425. Railroad Economics (The last of a course lectures by Mr. Ackworth; delivered in London. It touches upon the municipal railroad systems on the continent). R R Gaz–Jan. 3. 1400 w.

3426. The King Bridge Co.'s Ore Hoists and Conveyors . Ill. (A conveyor of simple design used in unloading from boats to cars). R R Gaz–Jan. 3. 1000 w.

3428. Matching Re-Sawed Rails (Method used to assort and distribute re-sawed rails in order that the joints may match). R R Gaz–Jan. 3. 800 w.

3430. High Speed Compounds (Comparison between simple and compound locomotives, especially at high speed). R R Gaz–Jan. 3. 1500 w.

3431. A Study in Operating Expenses—Periodic Traffic. R. L. D. (Experience of the Southern Pacific Co.). R R Gaz–Jan. 3 1500 w.

3433. Locomotive Expenses vs. Cost of Transportation (Abstract, with comment on a paper before the Western Railway Club, stating that the important question is how much does haulage cost per ton mile, not how much does it cost to run the locomotive). Ry Mas Mech–Jan. 1000 w.

3434. The High Speed Brake. From a paper by R. A. Parke Description of the operation as brought forth in a paper read before the New England Railroad Club). Ry Mas Mech–Jan. 1100 w.

†3458. The System of the Detroit Railway Company (A very fully illustrated description of a large electric railway plant). St Ry Jour-Jan. 3600 w.

†3459. Urban Growth and the Electric Railway. Louis Bell (Discussion of the effect of local railways on the value of real estate, and time saved by business people. Illustrated by a map of Boston, showing the curves of a fifteen minute and half-hour ride from business in 1888). St Ry Jour–Jan. 3800 w.

†3460. The Breakage of Street Car Wheels. R. J. McCarty (An examination into the causes for the breakage of car wheels). St Ry Jour–Jan. 1800 w.

†3461. Electric Railway Practice in the United States (An excellent monograph of present practice, well illustrated and up to date). St Ry Jour–Jan. 10400 w.

†3462. Electric Conduit Construction on Amsterdam Avenue, New York. (The line, which is the extension northward of the Third Avenue line, is now about completed. Views and drawings fully illustrate construction). St Ry Jour–Jan. 800 w.

†3464. Street Railway Roadbed. Mason D. Pratt (Illustrated descriptions of early types and patents of rail sections and splices). St Ry Jour –Jan. 1800 w.

*3481. Rail Guards (The subject is discussed editorially, and numerous examples of both wooden and iron guards given). Eng, Lond–Dec. 27. 2200 w.

3491. About wrecking Trains (Description of the wrecking service and equipment on the N. Y., N. H., & H. R. R. They get their train off in five minutes). Ry Rev-Jan. 4. 2200 w.

3501. Building Temporary Trestles Over Washouts and Burnouts). George J. Bishop (A paper prepared for the Amer. Assn. of Bridges & Buildings, but not read. The article treats of the organization and equipment required for such emergencies, with special reference to repairs of badly side washed embankments) Ry Age–Jan. 3. 3000 w.

3502. Pneumatic System of Handling Switches and Signals. (The air at 80-lbs. pressure, operated by pipes and valves, acts as the moving power. The valves and switch are illustrated by cuts and switch indication fully explained). Ry Age–Jan. 3. Serial. 1st part. 1100 w.

3524. What Next in Electric Railway Work? J. R. Cravath (Read before the Chicago Elec. Assn. A brief outline of some of the new engineering features that will probably enter into electric railway work in the immediate future). Elec Rev–Jan. 8. Serial. 1st part. 2200 w.

3529. Air Brakes (Two papers, with discussion, read before the New England Railroad Club, on air-brake equipment of passenger and freight cars. The papers are practical in their treatment and cover the subject well). R R Gaz–Dec. 13 6500 w.

3530. Performance of Compound Locomotives (Tabular statement of the principal points of interest in a number of simple and compound engines relative to long service and fuel consumption). R R Gaz-Dec. 13. 500 w.

3534. Wide Fireboxes for Locomotives (A discussion of the paper on "Wide Firebox Locomotive Boilers," read before the Western Railway Club). Eng News–Dec 12. 3500 w.

3540. Railroad Grade Crossings Under the Illinois Law (The practical working of various Illinois laws). R R Gaz–Jan 10. 2500 w.

3541. Locomotive Service. J. H. M'Connell (A paper read before the Western Railway Club, on working efficiency, tonnage rates, performance and cost, with suggestions for improvements). R R Gaz–Jan. 10. 2000 w.

3543. A Railway Division and Its Work (An article that should be read by every railroad manager. The character of the road is fully described; the organization of the departments, their equipment, and operation are given in detail. This is an actual case in the N. Y., L. E. & W. R. R. on its Delaware division). Eng News–Jan. 9. 8000 w.

3544. The Division Superintendent and His Work (Defining the duties and responsibilities of a railroad superintendent, and commenting on an address before the Amer. Railway Assn., by Col. H. S. Haines, who says that if a man is held responsible, he should certainly have control of the work). Eng News–Jan. 9. 1800 w.

3545. The Passaic and Newark Electric Railway (A well illustrated description). Eng News–Jan. 9. 1300 w.

SCIENTIFIC MISCELLANY

Preservation and Arrangement of Current Special Trade Literature.

PROBABLY most engineers have felt the want of a system whereby the valuable part of the current trade literature, such as catalogues, circulars, price-lists, reports, tables of data, etc., might be permanently retained and arranged for convenient reference. Mr. William H. Bryan appears to have worked out this problem so satisfactorily that we present an abstract of an illustrated article in *Journal of Engineering Societies* for November wherein he describes it. He says with reference to this class of literature that the want of an efficient system "prevents any considerable use being made of it, and greatly reduces—if it does not wholly destroy—its value. Very early in my own experience I found that I must adopt a system which would make it possible to put my hands immediately upon all the accumulated matter upon any one of many different subjects. As other engineers have no doubt been confronted with the same difficulties, I have thought it might be of interest to explain the solution which I finally reached.

"Any satisfactory plan must, of necessity, be simple in design and arrangement, complete, occupy little space, and not be expensive in first cost. It should be possible to remove and replace any single pamphlet without disturbing the others. Above all, the system must be so nearly 'automatic' as to require the minimum of thought and labor to maintain it at its highest efficiency."

After trying various methods and finding them all inadequate, Mr. Bryan found it necessary to change the last system adopted, in order to get the full value of the matter he had collected for years, embracing over one hundred subjects. Referring to the illustrations, Figs. 1 and 2, the method will be easily understood from Mr. Bryan's description quoted below.

"The accompanying sketch, Fig. 1, indicates my solution of the difficulty. I had a case of shelves made, of shape and dimensions shown. There are five shelves, each forty inches wide and thirteen inches high in the clear. The ends, tops, and facings of the shelves are of antique oak, the rest of the case being of ordinary material—poplar, I believe. The case is on rollers.

"I then ordered five dozen 'perfection' letter-file cases of standard size, which is 12"×10½×2¾ deep (Fig. 2). I had partitions placed in forty of them, giving me eighty divisions of about 1⅜" depth, for ordinary use, the remaining twenty being full depth and intended for those subjects on which an unusual amount of matter had or might be accumulated. The cases are sufficiently large to receive any of the standard sizes of catalogues or pamphlets. In fact, there are but few odds and ends of eccentric shape that cannot be handled. The case of shelves cost $7.00, and the letter files $16.50, being $2.50 per dozen, with an extra charge of 10 cents per case for the partitions,—a total of $23.50.

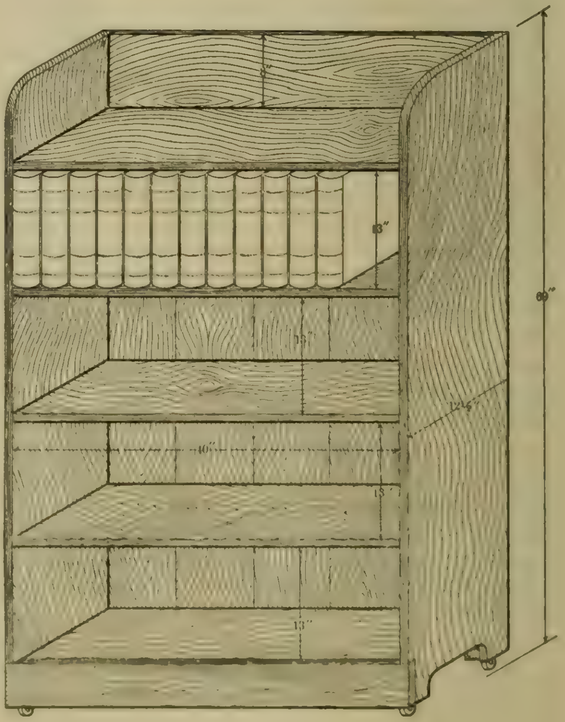


FIG. I.

"Each of the five shelves contains twelve filing cases, with three or four inches of space to permit easy handling, as well as some overcrowding of cases, or even an additional case on each shelf.

"Each of the one hundred divisions is numbered, and bears also a label indicating its contents. In my desk I keep an index, which is a copy of the labels on the individual cases. When the literature is received, it is first examined to determine whether it appears worthy of preservation. If worth saving, it is placed temporarily in a convenient drawer in my desk. When this drawer becomes filled,—which, in my own case, often happens two or three times a month,—all the accumulated matter is gone over again and examined more carefully. On each pamphlet which I decide to preserve, I mark the number of the filing division into which it is to go. The whole is then turned over to an assistant, who files the pamphlets in their places.

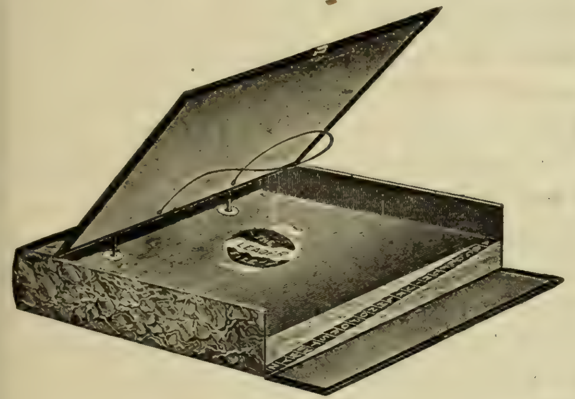


FIG. 2.

"When I desire to look up on any particular subject, I turn my index, I ascertain the number of the division, and request an assistant to bring me the proper case. As my system of indexing is alphabetical, however, it is frequently quite as convenient to go directly to the shelves and pick out the case desired. If a single pamphlet is being consulted, it can, when I am through with it, be placed temporarily in the receiving drawer, if there is not time enough to file it away permanently.

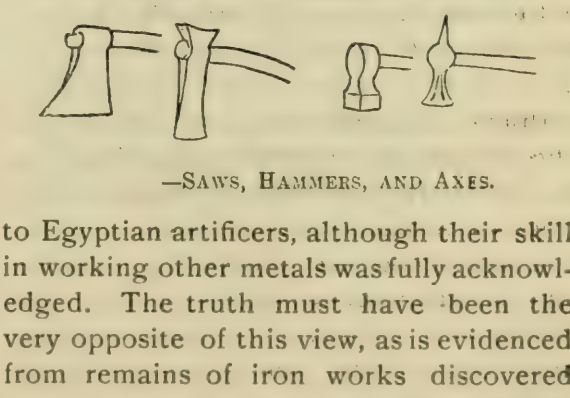
"In practice, I have found that still further division is necessary on some subjects. To carry these out, I use large manilla envelopes, each bearing a subheading corresponding to the branch of the subject it serves.

"To carry out the system in its best shape, it is necessary to go through the cases carefully every year or two, making provision for new subjects which have arisen, relieving over-loaded divisions, and weeding out duplicates and matter which has become antiquated or is of doubtful value.

"The system represents an investment of but $23.50, but its value to me is many times that amount. If I include its contents, I can hardly place a value on it, as much of the matter could not be replaced. I can assure you that the ability to put my hands at once upon all the matter of this character which I have accumulated for years, on over one hundred subjects, is a profound satisfaction, and I feel that I have mastered the pamphlet-filing problem for some years to come at least."

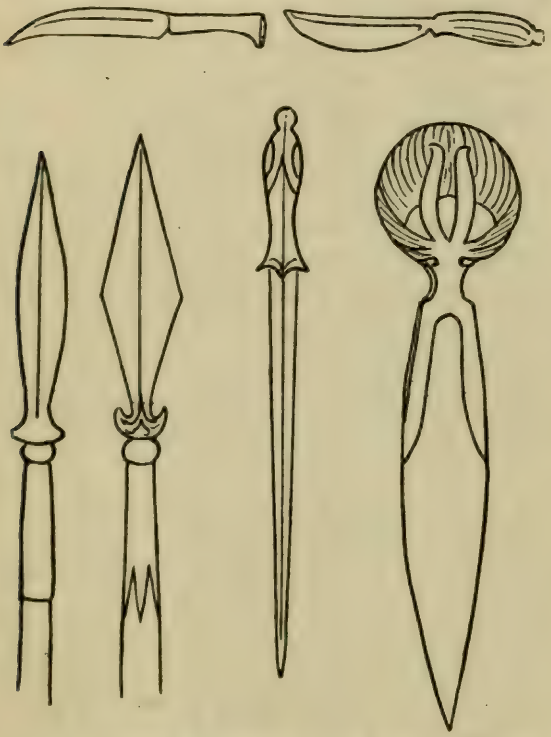
Iron Working in Ancient Egypt.

THAT writers upon metallurgic arts who have assumed that working in iron was comparatively unknown to the ancient Egyptians (and there are many, many such writers) are wholly in error in this is proved by an article in *Industries and Iron* (Dec. 13). Until recently some authors claimed that iron was a metal practically unknown to Egyptian artificers, although their skill in working other metals was fully acknowledged. The truth must have been the very opposite of this view, as is evidenced from remains of iron works discovered during excavations in the valley of the Nile, and the unearthing of many iron im-



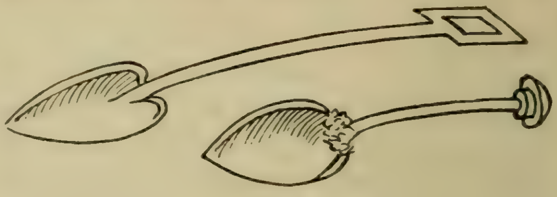
—SAWS, HAMMERS, AND AXES.

plements of war and of the arts of peace which evince a skill in fashioning iron of no mean order. Out of a large number of illustrations of iron articles discovered in a more or less preserved condition, we have selected only four groups. To these must be added agricultural implements in variety, such as ploughs, hoes, reaping-hooks, etc.; also other domestic articles, and even an iron chariot. It has been popularly supposed that iron ploughs are of modern origin; but the ancient Egyptian plough comprises every essential of a modern iron plough, except a wheel on the beam for gaging depth of furrows and a coulter for cutting tough turf in sod-land.



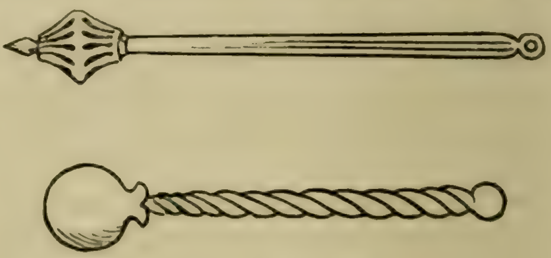
—Knives, Daggers, and Javelin Heads.

" Although the public museums throughout the civilized world have only a meager collection of the products of this kind of Egyptian craftsmanship, the country itself abounds in proofs that iron working was one of the most important industries of its earliest known inhabitants. Some of the remains of the great iron works of the Pharaohs show how systematically and on what an extensive scale this industry was carried out. Within the area of these mines and smelting furnaces the remnants of elaborate fortifications for the protection of the workmen have been discovered, as well as barracks for the accommodation of soldiers, who in those times fulfilled the double function of being military protectors of the miners, and, at the same time, their slave driving masters. Records, too, of these mining operations were kept on enormous slabs of stone, engraved by successive generations of the Pharaohs. Many of these hieroglyphical writings are still visible, and it is supposed that, if they could be clearly deciphered, much information might be obtained about the history of Egyptian mining and metallurgy.



–Spoons.

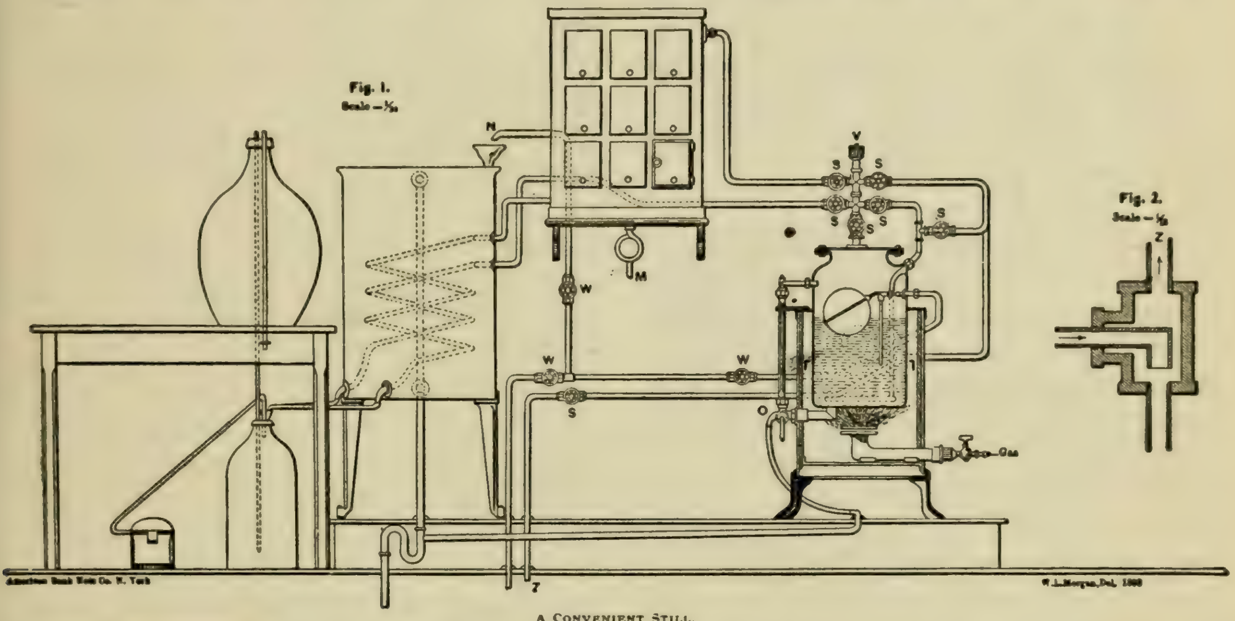
" Beneath the ruins of other places somewhat similar inscriptions have been unearthed, but, as these are often on less enduring plates of metal, their purport is still a matter of conjecture. Where such ' finds ' are made, however, it is not unusual to meet with the remains of other things of interest. Agricultural implements, for instance, made of iron, have been brought to light in the vicinity of such slabs. These sketches represent the originals largely 'restored,'—from drawings found at Thebes,—their condition, when dug up, being merely fragmentary. Yet the lion in bronze which stood upon the spot from whence these were taken has for three thousand years scathelessly resisted all the atmospheric influences which were so destructive to them. In fact, the remarkable manner in which bronzes have maintained their preservation, whilst the ironwork has so generally corroded into a mere crumble of rust, or disappeared altogether, is the only explanation of the curious paucity of iron



—Maces.

relics which we possess of the ancient Egyptians.

"It must be admitted that their processes for extracting iron from the ore do not appear to have been of a very superior order, because the vast heaps of slag that are found in the iron-mining localities of Egypt are said to contain from thirty to fifty per cent. of iron. This was about the proportion of 'waste'—it must not be forgotten—found in our own slag up to the beginning of the present century, when fortunes were made by the invention of new methods of converting it into serviceable metal. It has, therefore, been said that fortunes probably await those also who have enterprise enough to apply this process of refinement to the waste stuff lying about the gold mines of Egypt, whether they be iron, silver, or gold."



A Convenient Still.

A Convenient Laboratory Still.

THE still illustrated in the engraving herewith was designed by Professor Charles E. Wait, and is illustrated and described in the December number of *The Journal of the American Chemical Society*, from which we have prepared the following abstract. The still has proved eminently satisfactory in use, and it is a model piece of apparatus. The author says that, in designing this still, he proposed to utilize steam from the large boiler used for heating the building in which it was placed, and also to provide for the use of gas fuel when steam was unavailable for heating.

The still is encased in wrought iron, with a lining of asbestos, and is provided with a float which automatically regulates the flow of water from the supply-pipe. It has a capacity of seven gallons at a single charge, and is made of heavy copper, tin-lined. It has a water-gage showing the height of the water in the still; also an exit for steam, and safety-valve, *V*; an inlet for steam through a coiled perforated block-tin pipe; an outlet, *O*, for cleaning out the still; and a heavy disk gas-burner. There is a conveniently-arranged drying-oven and a large condenser, carrying two block tin worms, one direct from the still, the other from the oven, both delivering water to a carboy resting on the floor. When steam is taken from the large boiler, provision is made, by an arrangement seen in Fig. 2, located at *Z*, beneath the floor, to cleanse the steam, before it reaches the still, from the water mechanically carried into the pipes. The water returns to the boiler, while the steam passes to the still. By the arrangement of the steam-valves, *S*, it is possible to deliver the steam to the empty still, where it is again washed, and may then be passed either to the oven, or directly to the condenser, or to both. Or the steam from the boiler may be taken directly to the oven, or to the condenser, or to both. When a small quantity of steam is admitted to the still, most of the distilled water is condensed in the oven, and is caught in a copper tin-lined vessel underneath, through the valve, *M*, a part passing to the condenser and then to the glass vessel, from which it may be forced to the carboy above. When there is no steam in the large boiler, gas is used, the water being kept in the still at a constant level by the automatic arrangement before mentioned and seen in the sketch. In this case the steam may be passed to the drying oven, or directly to the condenser, or to both.

With steam twenty-six gallons of distilled water per day is the capacity, but Professor Wait says that with gas fuel he has produced distilled water at the rate of one hundred and twenty-six gallons per day. A convenient system of piping has been arranged for supplying water to the still and condenser,—to the latter at *N*, and under control of valves, *W*, as seen in the sketch. The still and condenser are both connected with the waste, and may be emptied and cleaned when necessary. Other details of this apparatus are shown in the drawings.

Brakes and Fenders for Trolley Cars.

CONCERNING these much-debated appliances Mr. Oberlin Smith has made suggestions in *The Iron Age* (Nov. 21). To be killed out and out is, to a reasonable man, a thing not to be supremely dreaded, except that such a catastrophe may leave to those he loves a legacy of trouble; but to be half-killed—to add to the incapacity of helping others the dreadful contingency of becoming a personal burden to be carried painfully through life by those who were formerly sustained and supported—may well be dreaded, even by the bravest. In this view legs and arms become more valuable than life, and most men of independent mind would prefer death to being permanently crippled. The saving of life, regardless of injury to the limbs, appears to have been hitherto the aim of fender inventors, and Mr. Smith—justly, we think—takes the ground that this is a wrong standpoint from which to view the subject. He says:

"Among the numerous rapid-transit problems now before the public one of the most virtually interesting ones is that of brakes and fenders for street cars. Some of the reformers in this line strenuously urge the improvement of the car brake first, and there is certainly no invention more needed just now than a perfect brake,—that is, as perfect as any brake can be which will do no more than stop the wheel and allow it to slide upon the track, or nearly so. Some good device will doubtless be forthcoming, now the inventors seem to have fairly taken hold of it. Electric brakes are often mentioned, but it is evident that it will not be safe to trust to any of them, if they are dependent for their power upon the circuit alone, because of the danger of a stopping of the generator, an accidental breakage of the line, or the removal of the trolley pole from the wire. What combination will be devised to get the best results remains to be seen, but we certainly must get the momentum of these modern cars of Juggernaut under the greatest measure of control, and that with the utmost rapidity of action possible. The fender problem is a vastly more difficult one, and does not seem to have been attacked from the proper standpoint by most of the numerous fender inventors, many of whom seem, judging by their works, to regard a street car as moving in an absolute plane over a level floor. They, moreover, even where the streets are reasonably smooth, seem to provide only for the body of the victim, without regarding his arms and legs, treating him just as if he were a barrel of sugar or a bag of flour. They seem to forget that in many accidents a man or a child may fall with toes or fingers outstretched toward the approaching car. In such a case a set of finger points, from a quarter to a half an inch thick, buried perhaps in interstices between cobble stones, do not form a very large abutment for any kind of a fender to strike against with a view to absolute removal. The result is that any wedge-shaped part of a human body, such as the limbs referred to, is almost sure to raise up any sort of a fender, thus grinding the victim more surely to his death.

"It would seem, therefore, that the forward part of any such life-saving device must run its chances of being able to occasionally strike a person so as to pick him up and give him a free ride, or to push him off sideways. In the event of a failure to do this, it should absolutely get up out of his way, so to speak, without bruising him, and leave him to the tender mercies of some kind of a guard further back, which should at all hazards prevent the wheels rolling over him. On a level floor this would be easy enough, as such a guard would extend entirely across the car, and almost touch the floor by means of any preliminary action occurring at the front fender. Unfortunately this happy result cannot be well secured on rough streets, but our city governments should absolutely insist upon wheel guards running not more than a quarter or, at most, a half an inch above the surface of the rails secured positively from rising, and attached to the trunk close in front of each and every wheel. How close this can practically be run to the pavement between the rails depends upon the particular nature of each street surface in question; but that it should be very low and very rigid goes without saying, even at the risk of its occasionally striking the ground and impeding the car. This would sometimes grind up fingers and arms, but could hardly run over and crush the whole body. Whether the obvious plan can be accomplished of running over passengers without hurting them by leaving a high enough clear space under the axles and motors for them to lie in comfortably and gaze up to the floor of the car is very questionable. It certainly cannot be done without a change of design. If this could come to pass, it would be necessary to guard only a few inches in width in front of the wheel itself, in which case the guard could almost touch the rail."

Globular Lightning.

MOST of the observations of that rare atmospheric phenomenon known as globular lightning have been made by rude men, without training in scientific observations, and without skill to describe accurately that which they actually saw. Exaggeration has doubtless often colored reports of such occurrences. An account of an incident witnessed by Prof. O. C. Marsh, of Yale University, published in the *American Journal of Science* for January, will be accepted by all as free from the defects named, and, though brief, is of scientific interest. Professor Marsh writes:

"On Tuesday, July 23, 1878, I was on board a large yacht at anchor in the harbor of Southampton, England. About two o'clock in the afternoon, when we were about to sail, a violent thunderstorm came up from the west, and, as it passed over Southampton, several bolts descended, one of which, as I afterwards learned, struck a church. As the first drops of rain came down on the yacht, I was standing in the after companion-way, looking forward, when my attention was attracted by a bright light apparently near the upper part of the foremast. When I first saw it distinctly, it was about half-mast high, and was falling slowly and directly toward the deck. This light was a ball of fire, a delicate rose-pink in color, pear-shaped in form, with the large end below, and appeared to be four or five inches in diameter and six or eight in length.

"When it struck the deck, about forty feet from where I was standing, there was a loud explosion, and it was some minutes before it could be ascertained what damage had resulted. The mate, who was near the mainmast, about twenty-five feet from where I stood, was knocked down, but soon recovered. The same bolt, or part of it, also passed in front of the foremast, down a windsail ventilator, into the galley, where it knocked a large tin pan from the hands of the cook, and upset things generally in the culinary department, but injured no one seriously. Of the crew some were on deck and some below, but none were really harmed, although a few were badly demoralized. A strong ozone like odor was observed immediately after the explosion, and this remained perceptible for some time.

"The officer in command of the yacht, Captain Matthews, who was forward at the time, and escaped without injury, stated that just after the stroke he saw streaks of lightning running around on deck like snakes. I was myself only dazed for a moment by the explosion, and saw distinctly that the deck forward was illuminated with a bright confused light. The owner of the yacht, George Peabody Russell, and his other guests, had gone below when the storm began, and suffered no harm, except possibly from fright, as they were still further away from the stroke.

"As soon as the storm had passed, I made careful notes of the whole occurrence, with drawing and measurements, as I was much interested in the subject, and it was the first instance of the kind I had seen in close quarters. An inspection showed that the vessel itself had sustained no material damage; and not even permanent marks were left on the deck where the ball of fire exploded. A number of yachts were at anchor quite near our vessel at the time,—among them the white 'Sunbeam,' just home from her well-known voyage,—but we saw no indications that any of these had been struck."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

*3011. Opposition to Inventions. William C. Dodge. Eng Mag-Feb. 3000 w.

†3058. Experimental Method of Determining the Effective Centre of the Light Emitted from a Standard Photometric Burner. D. S. Jacobus (Presented at the N. Y. meeting of the A. S. M. E. Describes and illustrates apparatus and photometric method employed at the Stevens Institute Department of tests, in testing car lamps). Trans Am Soc of Mech Eng-Dec. 800 w.

†3109. Abstract of Lecture Delivered before Senior Class of Stevens Institute of Technology. Coleman Sellers (Interesting and covering in popular style nearly the whole field of engineering, and stating the special educational equipment, for success in different branches of the profession). Stevens' Ind-July. 4000 w.

†3118. Corea and the Siberian Railway. M. F. A. F. (Descriptive of the country, people, towns, and interesting features). Fortnightly Rev-Dec. 6000 w.

3161. The Savoyarde—The Bell of the Church of the Sacred Heart, Paris. Ill. (From *Le Genie Civil.* An account of the founding of the largest bell in France (18 tons), and of its transportation over common roads by means of a special truck, drawn by twelve yoke of oxen. Incidentally a brief account of many other large bells is given and a description of the process of bell founding in general is also presented). Sci Am Sup-Dec. 21. 3000 w.

3163. Manufacture of Photographic Plates. From *La Nature* (Interesting illustrated description). Sci Am Sup-Dec. 21. 1400 w.

3167. Investigation of Bovine Tuberculosis, with Special Reference to its Existence in Iowa (Abstract from Bul. of Iowa Agricultural College Experiment Station giving important results and conclusions). Sci Am Sup-Dec. 21. 4500 w.

*3197. A Spherical Catenary in Stereo (Description of the properties of this curve, and a mathematical discussion of it, also description of an optical effect of the curve). Engng-Dec. 13. 700 w.

*3208. Note on a Photographic Method of Determining the Complete Motion of a Gun during Recoil. Albert Cushing Crehore and George Owen Squier (Describes a method applied to the investigation named whereby any body, moving body, may be made to trace its own path mechanically, upon a surface prepared to receive and retain the trace). Ind & Ir-Dec. 13. 2500 w.

*3211. The Iron of Ancient Egypt (Proves that, contrary to general opinion, the ancient Egyptians were not unskillful iron workers. Illustrations of implements and weapons, now known to have been used by them, are given to substantiate this allegation). Ind & Ir-Dec. 13. 1300 w.

3239. A Wonderful Ruling Machine. From *N. Y. World* (Popular description of the most perfect ruling machine ever constructed for producing gratings used for decomposing light in optical investigations. It rules from 15,000 to 125,000 perfectly parallel and perfectly cut lines to the inch). Age of St-Dec. 21. 1000 w.

*3246. Rise and Fall of the Orange Industry. J. F. Richmond (The history of orange growing in Florida, with the prediction that the industry will be revived in a very few years). Chau-Jan. 2200 w.

†3252. A Convenient Still for the Laboratory. Charles E. Wait (Illustrated detailed description). Jour Am Chem Soc-Dec. 500 w.

†3256. The Relationship of the Heat of Vaporization of Gases to Their Density and also to Their Boiling Point William L. Dudley (An intricate and very able investigation, from which is deduced the law that in any homologous series the heat of vaporization in a unit of volume of the vapor, unde the same conditions as to temperature and pressure, is proportional to the density, and also to the absolute boiling point. It is predicted that when more complete data are obtained, some interesting developments in this direction may be expected). Jour Am Chem Soc-Dec. 1400 w.

*3298. The Development of Sculpture in America. William Ordway Partridge (General remarks on the art, with a history of its development in America, giving brief accounts of some artists who have contributed to the work). Forum-Jan. 6500 w.

*3306. Chimney Felling from Aberdeen. From *Aberdeen Free Press* (Interesting description of the felling of three chimneys, 50, 110, and 175 ft. high). Arch, Lond-Dec. 20. 1100 w.

*3319. On a New Form of Lighthouse Refractor. John A. Purves (Describes a new prismatoidal lens for lighthouses, with diagrams. This lens is claimed to be more powerful and of less weight and bulk than the Fresnel). Eng, Lond-Dec. 20. 1700 w.

*3330. Pamphlet Filing. William H. Bryan (Describes and illustrates a very convenient method of preserving special trade literature, such as catalogues, cards, circulars, reports of tests, etc.) Jour of Assn of Eng Soc-Nov. 1400 w.

†3362. Borchgrevink and Antarctic Exploration. A. W. Greely (A brief account of the origin of the expedition and of the important results achieved, both scientific and practical). Cent Mag-Jan. 1000 w.

†3363. The First Landing on the Antarctic Continent. Ill. C. E. Borchgrevink (An account of the recent voyage of the whaler "Antarctic"). Cent Mag-Jan. 10000 w.

†3366. Note on Globular Lightning. O. C. Marsh (A minute and extremely interesting account of an instance of this rare form of lightning, as accurately noted by a really competent observer — one of the editors of the journal quoted). Am Jour of Sci-Jan. 500 w.

†3370. Note on the Analysis of Contrast-Colors by Viewing, Through a Reflecting Tube, a Graded Series of Gray Discs, or Rings, on Colored Surfaces. Alfred M. Mayer (Important as relating to color contrasts in articles of manufacture of high grade, in which choice and arrangement of colors is involved). Am Jour of Sci-Jan. 1200 w.

†3371. A Very Simple and Accurate Cathetometer. F. L. O. Wadsworth (Illustrated detailed description of a new cathetometer, designed by the author and, which, while claimed to be equal in accuracy and convenience to the best German and English cathetometers for laboratory purposes, can be made for a cost of less than one-tenth of what the best of these instruments have hitherto cost). Am Jour of Sci-Jan. 2400 w.

†3372. Helium, Its Identification and Properties. C. A. Young (Account of the discovery and identification, with what has thus far been ascertained as to its properties). Pop Sci M-Jan. 2400 w.

3437. The Cold-Storage Rooms in the Reading Terminal (Illustrated detailed description. The rooms are refrigerated by ammonia compressors, distribution of effect being by brine circulation). Eng Rec-Jan. 4. 1800 w.

*3443. The Treatment of Trades Waste. William Naylor (Abstract of a paper read before the Inst. of Civ. Engs. An interesting résumé of progress in reducing waste in a great variety of manufacturing industries). Ind & Ir-Dec. 27. 6000 w.

*3446. Megass and Refuse Furnaces. William Price Abell (An illustrated description of means and methods of using megass and other refuse as fuel and a résumé of progress in the art). Ind & Ir-Dec. 27. 1800 w.

†3467. Floating Sand. An Unusual Mode of River Transportation. Frederick W. Simonds (A description of a remarkable phenomena, which has never yet received a fully acceptable explanation, but which may be more or less related with formation and obstruction of river channels). Am Geol-Jan. 2500 w.

*3470. Experiments on Wind Pressure. (An important experimental study of wind pressure upon planes with reference to the determination and measurement of the partial vacuum produced behind a flat plane by winds blowing upon its face, set at different angles with the direction of the wind. Diagrams illustrate the apparatus used and method of experimenting, and graphical representations of different effects aid in elucidating the text. Tabulated results are also presented. The results of this and kindred experiments are likely to modify existing formulæ for calculating wind strains). Engng-Dec. 27. 2200 w.

*3472. The Science and Art Department and Education (Review of the report of the Royal Commission on Secondary Education. The South Kensington influence is regarded in the report as having been deleterious to the field of school education in Britain. This view of the case, the reviewer thinks, has not been well established. On the other hand the results attained are considered as justifying the faith in the possibilities of the schools under the control of the Science and Art Department). Engng-Dec. 27. 1800 w.

†3510. Graphics of Thermodynamic Law. R. H. Thurston (An illustration of the value of the graphic method in the discussion of special thermo-dynamic problems, being the application of this method to the second form of the general equation expressing the first law of thermodynamics as formulated by Clausius and Rankine). Jour Fr Inst-Jan. 1200 w.

†3517. Energy Equivalents. Edward J. Willis (Tables whereby the labor of a great variety of engineering calculations is reduced to simple multiplication and division. The subject matter was first published in the *American Machinist*, but is here presented in tabulated form). Stevens In-Oct. 1200 w.

†3548. The Rubber Trees of British West Africa. Hawthorne Hill (A new source of rubber promising to be of great value to commerce). Ind Rub Wld-Jan. 10. 900 w.

†3549. The Rule of Thumb in the Rubber Factory. Stephen P. Sharpless (Condemning some practices of rubber manufacturers, and suggesting chemical investigation). Ind Rub Wld-Jan 10. 1000 w.

†3550. Considerations in Catalogue Making. C. D. Frost (Nine points of importance to be considered in the making of a trade catalogue). Ind Rub Wld-Jan 10. 1000 w.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Otis Allen & Son, Lowell, Mass., U. S. A.= Pamphlet, 24 pp. "The Artificial Preservation of Timber." Contains much information upon the waste of forests in America, the durability of timber of various sorts and processes for preserving timber, and, in particular, the kyanizing process carried out at the works of this firm Well illustrated in half-tint. (6) Sheets illustrating in half-tint examples of timber after use both kyanized and unkyanized, examples of engineering in which kyanized timber has been successfully applied, etc.

Brown & Sharpe Manufacturing Co., Providence, R. I., U. S. A.=Catalogue, 366 pp. Describing and illustrating cutters, gears, gages, micrometers, callipers, etc., etc. Darling, Brown & Sharpe, U. S. standard rules, cast steel try-squares; American standard wire gage, and a variety of tools for accurate measurements. To the above have been added in 1895 a line of universal milling machines; power lapping and automatic gear cutting machines; gear rim milling machine, screw machines with automatic chuck and wire feed; polishing and finishing machine with brake; case-hardening and hard-coal tempering furnaces; hand milling, and taper milling attachments for milling machines; driving fixture for high speed milling attachments; single dial index centers of different sizes; flanged vises; milling machine screw arbors; centrifugal water pump; geared water pump; and new sets of tools for milling machines. This is a notable advance of lines for a single year. Formulas and tables of great utility and complete indexing render this one of the most valuable catalogues for the use of mechanical engineers.

The Cumberland Iron and Steel Shafting Co., Cumberland, Md., U. S. A.=Catalogue, 12 pp. Turned, ground, and highly-polished steel shafting.

Harry C. Sping, St. Louis, Mo., U. S. A.= Catalogue, 100 pp. Mill, factory, plumbers, steam and gas fitters', and engineers' supplies.

Smith and Anthony Company, Boston, New York, and Chicago, U. S. A.=(a) Catalogue, 112 pp. "Hub" stoves, ranges and furnaces; (b) catalogue of hot water heating appliances.

Automatic Circuit Breaker Co., Newago, Mich., U. S. A.=Catalogue, 28 pp, illustrating and describing automatic circuit breakers.

Cortright Metal Roofing Co., Philadelphia and Chicago, U. S. A.=Catalogue, 16 pp. Illustrates and describes metal tiles, metal slates, ornamental shingles, and roofing sundries.

Master Builders' Exchange of the City of Philadelphia.=Hand book, 304 pp.; being a catalogue of the permanent exhibition of this exchange, and containing valuable information and interesting statistics of building.

T. C. Joy & Co., Titusville, Pa., U. S. A.= Catalogue, 40 pp. Illustrates and describes radiators for hot water and steam heating.

The Ingersoll-Sergeant Drill Co., New York, U. S. A.=1895 Catalogue, No. 40, 146 pp. Describes and illustrates at length, and in detail, rock drills, stone channeling machines, quarry bars, gadders, and special quarrying machines. This catalogue and other trade publications issued by this company are among the most thorough, complete, and artistic in modern trade literature.

The Solvay Process Co., Syracuse, N. Y., U. S. A.=Pamphlet, 20 pp. The Semet Solvay retort coke ovens with recovery of by-products. Half-tint illustrations.

Sanitas Manufacturing Co., Smith & Anthony, proprietors, Boston, Mass., U. S. A.=Catalogue, 64 pp., illustrating the "Sanitas" plumbing appliances, and other plumbing specialties.

Hilles & Jones Co., Wilmington, Del., U. S. A.=Catalogue, 32 pp. Illustrating and describing a special line of machine tools for working iron, and steel plates, bars and structural shapes.

Emerson Electric Manufacturing Co., St. Louis, Mo., U. S. A.=1895 Catalogue, 42 pp., illustrating and describing electrical appliances.

A. L. Ide & Son, Springfield, Ill.=Special Catalogue. (*a*) Illustrating the "Ideal" self-oiling steam engine; (*b*) illustrating and describing the several devices used for increase of belt contact and reduction of space required for steam plants of given power, and improvement in methods of power transmission; (*c*) leaflet "out of date and up to date" bearings for engines and dynamos; (*d*) leaflet. The Ideal High Art Engines; (*e*) list of purchasers and users of 13,000 horse power developed from "Ideal" engines in the United States and foreign countries; (*f*) pamphlet, 28 pp., illustrating and describing in detail the construction of the "Ideal" engine and the self-oiling devices used therewith.

Frick Company, Waynesboro, Pa., U. S. A. =Catalogue, 216 pp. Illustrating and describing refrigerating and ice-making machinery for use in cold storage depots, packing houses, breweries, ice factories, etc. 1 to 500 tons daily capacity; direct expansion or brine system.

Electric Heat Regulator Co., Mineapolis, Minn.; U. S. A.=Pamphlet, 24 pp., illustrating and describing an electric heat regulator for automatically controlling temperature, and applicable to steam, hot water, or furnace heating apparatus.

Joseph Dixon Crucible Co., Jersey City, N. J., U. S. A =Pamphlet, 16 pp. Graphite and its uses, especially in lubrication. Many examples of, and testimonials to, the value of graphite in the latter capacity are presented.

The Brown Hoisting and Conveying Co., Cleveland, Ohio, U. S. A., with branch offices at New York, Pittsburg and Chicago.=Catalogue, 83 pp. Elegantly illustrated in half-tone.

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THE MONEY QUESTION AND CONSTRUCTIVE ENTERPRISE.

By John R. Dunlap.

THE following letter from an appreciative subscriber in the West will explain itself:

To the Editor of THE ENGINEERING MAGAZINE,

I have enjoyed your publication as much as any other which has come to my table, and I subscribe for all the leading periodicals. But I am much disappointed at the appearance in your pages of the leading articles in your November, December, and January numbers, on the money question. I recognize the worth of the articles, but I subscribe for the leading financial papers, quarterlies, and reviews, in which I would expect to see such matter as this, and I cannot understand upon what grounds *you* give place to these articles by Messrs. Mills and White.

This is a criticism which I hope you will understand is made in a friendly spirit. I have a horror of the tendency which crops out in many publications with which we fall in love, of departing from the field in which we expect them to remain.

W. C. H.

Albuquerque, N. M., January, 1896.

This is a courteous and intelligent inquiry, and it is entitled to a full and frank answer.

In the official report of the United States Inter-State Commerce Commission dated June 30, 1894,—one year after the panic of 1893,—there occurs the following significant paragraph:

> "On June 30, 1894, there were 156 railways in the hands of receivers. The mileage of road operated by these defaulting companies is 38,869.96 miles. Eighty per cent. of this mileage is accounted for by 28 important lines. Of the 128 remaining, 59 were small lines of less than 100 miles in length, some of them being parts of larger systems, and some being lines still in process of construction. The total capitalization of roads in the hands of receivers was about $2,500,000,000, or about one-fourth of the total capitalization of the country."

If our correspondent will picture in his mind's eye the tens of thousands of engineers who were thrown out of employment, deprived

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of prospective engagements, or suffered decrease in their incomes as the result of this prodigious aggregate of railroad insolvency ; if he will form a mental estimate of the billions of capital employed in other lines of industry which were either wrecked or gravely imperiled by the same causes which produced this calamitous result in the railroad world ; and then if he will endeavor to calculate the contingent losses which accrued to the millions of individual workers engaged throughout all lines of industry,—if he will do this, he can perhaps form some idea as to what a modern panic costs a great people. And in the nature of things, the causes which can produce such direful effects must be of the highest concern to the men who are engaged in constructive and industrial enterprise,—in a word, to the readers of this Magazine.

Now the panic of 1893 was purely and wholly a financial one. It was born of the most astonishing array of insane legislation upon finance and banking that has ever been witnessed in the history of any civilized people. That our readers may clearly comprehend the net results of this legislation, it is worth while to reproduce here an extract from a speech by Prof. J. Lawrence Loughlin, delivered in Chicago in October, 1894. The status of our public finance has never anywhere been more concisely presented, or more appropriately characterized. To illustrate the heterogeneous character of our currency, he presented the following official statement showing its component parts on October 1, 1894, which will apply substantially to the present date :

	Coined or Issued.	In treasury.	In circulation.
Gold coin	$579,728,587	$79,602,339	$500,126,248
Gold certificates	64,845,699	55,260	64,790,439
Silver dollars	421,176,408	366,900,165	54,276,243
Subsidiary silver	75,054,481	16,809,713	58,244,768
Silver certificates	339,676,504	9,155,785	330,520,719
Treasury notes (1890)	151,609,267	30,113,893	121,495,374
United States notes (greenbacks)	346,681,016	79,397,535	267,283,481
Currency certificates	56,305,000	550,000	55,755,000
National bank notes	207,564,458	5,017,748	202,546,710
Total	$2,242,641,420	$587,602,438	$1,655,038,982

Commenting upon this exhibit, he said : "We have here a dime museum of finance,—'the greatest aggregation of curiosities ever before exhibited under one canvas in the world.' There are nine different and confusing kinds of money,—two kinds of gold money, four kinds of silver money, and three kinds of paper money. The sum total of the four kinds of silver money amounts to about the same as the sum of the two kinds of gold money. Briefly, about 35 per cent. is gold, 35 per cent. is silver, and 30 per cent. is paper. . . . If anything should make us pause and deliberate on the ways of regulating our monetary system, it would be that the loud-voiced, blatant demagogue is allowed to have unimpeded influence in regulating such an intricate mechanism as this."

This language seems almost like humor and ribaldry, but its every word is sober truth, and in no other form of expression can the situation be so fittingly described.

Back in the summer of '93, when agitation for the repeal of the Sherman Silver Bill was going on, there were thousands of intelligent men who believed that if we could stop the Government's monthly purchases of silver the trouble would be over. They saw that the silver advocates were both earnest and honest in the desire to maintain parity between gold and silver, thus insuring the discharge of all obligations upon the basis at which they were incurred ; and they felt that if the Government would suspend the coinage of silver, all fear of its readiness and ability to maintain gold payments would disappear. But experience soon demonstrated that in reality the silver question constituted only one phase of the problem. Immediately after the repeal of the Sherman Bill the drain of gold from the Treasury set in afresh ; one bond sale followed another in quick succession without checking the demand for redemption of the Government's fiat money ; and thus has arisen the growing popular demand for the retirement of the greenbacks. It is obviously necessary that these notes shall be retired, and we can never hope for stability in our financial affairs until they are safely out of the way,—until the government "goes out of the banking business" and transfers to the banks the burden of carrying a gold reserve and supplying the gold that may be needed for export. But well-informed men see clearly enough that even this would not cure all our ills. The trouble lies yet deeper. Our banking system is not only imperfect and inadequate to the proper conduct of the business of our people, but it is crude, old-fashioned, and far behind the science of modern banking, as practised in every other civilized country. What we need, and what we must have before we can enter safely upon that era of splendid prosperity which surely awaits us, is, first, a simple, safe, and elastic system of national bank currency, which can be readily issued or retired by the banks in response to the varying demands of trade, and which will be adequate in volume to supply the place of the greenbacks and Treasury notes ; and, second, such an amendment of the banking laws as will permit national banks, under proper restrictions, to establish branches in small towns and thinly settled districts throughout the country, to afford to our people the banking facilities which are necessary to the expeditious and profitable conduct of business.

Immediately the question arises, How is this reform to be accomplished? There is but one answer. It must come through the education of our people, and it can come in no other way. We live under a popular government, and as the people think, Congress will vote. Not until the country has declared itself in unmistakable terms can we hope for any adequate legislation in Washington; and, meanwhile, we must rely upon demonstrating to all the world the great wealth, the splendid resources, and the loyal patriotism of our people,—which have happily been so conspicuously proved in the recent public sale of government bonds.

Reasoning thus, it has seemed obvious to me that the surest and speediest method for accomplishing the end desired, must be through *the education of the leaders* of the people,—the proprietors, heads of concerns, chiefs of departments, superintendents, managers, and active men of affairs generally, who employ large numbers of men and who hold the confidence of the voters. It is precisely this constituency which The Engineering Magazine strives to serve, and I have, therefore, accounted it a matter of the highest importance that the financial problem should be treated in these pages from the point of view of the engineer and the practical man, rather than from the stand-point of the financier or the politician, as is usual in the financial and political reviews. Every resource has been exhausted in the effort to obtain the best thought of the foremost minds in the world; each and every phase of the problem has been clearly expounded by an expert; each subject has been treated in its relation to those which have gone before; and, as a whole, the series of papers would make a valuable text-book. That this may be appreciated, I present here a list of the titles and authors, with the date of each publication:

Aug. '93.	The Unit of Value in All Trade— As Fixed by Commerce Regardless of Legislation.	Edward Atkinson.
Sept. '93.	A Scientific Analysis of Money— A Standard of Value Mathematically Defined.	Emil Schalk.
Oct. '93.	The Real Currency of Commerce— Checks, Drafts, Notes and Bills of Exchange.	George S. Coe.
Dec. '94.	The "Baltimore Plan" of Currency Reform— Approved by the Bankers' Association of the U. S.	A. P. Hepburn.
Jan. '95.	Silver Coinage Historically Considered— A Masterly Review of Facts and Principles.	H. D. McLeod.
Nov. '95.	The Currency Problem and Its Solution— A Business Man's Idea of the Situation.	Abraham Mills.
Dec. '95.	First Principles in Money and Banking— The Currency Problem in American History.	Horace White.
Jan. '96.	Representative Money and Gold Exportation— An Excess of One Leads Inevitably to the Other.	Horace White.

As a timely and fitting addition to this series, it affords me pleasure to commend in the highest terms the very excellent article on "The Scotch System of Branch Banks," by Mr. J. Selwin Tait, which follows. This may, indeed, be fairly accounted the most important paper in the series, for the essential reason that it lays bare the tap-root of the whole difficulty. In addition to showing the great superiority of the Scotch and English system of banking over our own, Mr. Tait proves that by simply amending our national bank laws to conform with the modern system which has made London pre-eminent in the financial world, we can add the magnificent aggregate of $750,000,000 to the capital which is available for productive enterprise,—and this too of capital which is now needlessly employed in banking or lying idle and useless in our bank reserves. Here is a possible addition to our "circulating medium" which must satisfy the demands of even the wildest inflationists,—for as Mr. George S. Coe, the distinguished inventor of the clearing-house certificate, has clearly shown in these pages, (October, 1893) "the real currency of commerce" is made up of bank credits, with the checks, notes, drafts, and bills of exchange which are based upon them. If this fact can ever be driven home to the addled pates of our ten thousand philosophers of inflation, the money question will settle itself in short order. Afford safe and adequate banking facilities to the farmer, the village manufacturer, the artisan, and the small tradesman ; give him a credit in bank and a check book to make that bank credit available, and he will soon learn that actual money plays a very small part in the transaction of business,—he will, in fact, learn what the clearing-houses have taught the people of our large cities long ago, namely, that of all the stupendous aggregates of modern business transactions, less than $1 in every $20 is represented by the actual use of money.

And just here it seems proper to repeat what I said in these pages in December, 1894. "It requires no prophet to foresee that the question which must dominate all others in public interest during the coming twelve months, is that of reforming the polyglot system of currency and banking under which the commerce and industry of the United States are now struggling. . . . Back of the Populist demand for 'more money' and 'cheap money' ; back of the sentiment favorable to silver coinage upon some safe basis ; and back of the unrest and discontent which are manifest in all parties, there is the definite knowledge that our present currency system is both complicated and defective,—that at certain seasons it is inadequate to commercial requirements, and in times of panic positively dangerous to the welfare of our people. This is the vital defect which gives plausibility to all the financial vagaries now prevalent ; and whatever sins may be charged against the silver inflationists and the fiat money cranks, they must be credited with having finally aroused the conservatism of the country to a clear appreciation of the fact that financial reform is an imperative need.''

''It may be said that the movement for reform was inaugurated with the panic of 1893. The wholesale issue of clearing-house certificates, the widespread use of certified checks in place of money, and the premium, not on gold alone, but on currency as well,—these were object lessons in finance which brought home to every man the obvious truth that our currency system was defective, and that it lacked the essential quality of being readily expanded or contracted to meet perfectly legimate requirements.''

What was true at that time is true to-day.

In both houses of Congress, and notably in the Senate, there are blatant demagogues who wantonly proclaim doctrines which they know to be false; but in the Senate, as well as in the House, the overwhelming majority of the congressmen who stand for silver coinage or uphold the greenback, are sincerely convinced that they are right. They see that something is radically wrong, and they are simply following their best lights in the effort to solve the problem. More than this, they know that in thus upholding honest convictions they represent the sentiments of their people. In truth, the only kind of money that the present generation has learned anything about is government money and silver money, with an occasional glimpse of gold. It is logically necessary, therefore, that they should believe in the money which for thirty years they have been using; and though they are in error as to the true principles of finance, they are manifestly honest in the theories which they uphold. Nor does this condition of public opinion apply merely to a minority. The candid man must admit that the majority of our people believe that the government should issue our money, and many believe that the silver men have an element of honest truth in their platform. But with that conservatism which is the bulwark of free institutions,—which makes it always safe to trust the people,—a square halt has been called. The voters will not permit any additional coinage of silver, and already they are in the attitude of waiting for further information concerning greenbacks and government money generally. This is undoubtedly true of the people, and it is notably true of their honest leaders. In all the pages of political history a more heroic example of loyalty to plain duty and honest conviction has not been written, than in the frank declaration of Senator Mills, of Texas, that he regards it as impossible for this country alone to establish the free coinage of silver.

To the thoughtful man it must be apparent, then, that the paramount duty of this hour is to teach sound principles of finance,—to spread the light to the people who are waiting for it. This is a duty which rests, not upon our representatives in Congress, or some special set of men who comprehend the whole science of finance, but it rests equally upon all men of intelligence and influence. It should find expression in private conversation, in business correspondence, through the columns of the newspaper press, in the pages of the magazines and reviews, especially through the medium of commercial exchanges, boards of trade, and chambers of commerce,—and more important than all else, the demand for a sound currency and a civilized system of banking should be made so manifest at every political convention between now and next fall, that when the voters come to the polls for the presidential election in November next, there shall be absolutely no mistake as to the demand of the people of the United States for the best money and the best banking system that the world affords.

And now I want to go beyond the ordinary bounds of a magazine article for the purpose of saying, that the most valuable, the most comprehensive, the most complete, and the most convincing contribution that has yet been made to the literature of the money question as it exists in the United States to day, is the incomparable little volume by Mr. Horace White, entitled "Money and Banking," which has recently been published by Ginn & Co., Boston. In the issues of this Magazine for December and January last I attempted, in two articles made up of selected quotations, to convey some adequate idea of the value of this work. But to the man who wishes to thoroughly understand the situation which confronts us, and to be in a position to exercise an influence over the people of his community, these few extracts are wholly inadequate to the purpose. The book itself should be procured, and once in hand its reading will be found as pleasurable and inspiring as it is undoubtedly instructive. From cover to cover it deals in essential facts, rather than theories; and using the familiar events of our whole financial history to illustrate the obvious principles of sound finance, it makes the whole subject so clear that no reasonable man can possibly go astray.

In this little book, in exposing the fundamental fallacy of money issued by a government, Mr. White declares that "the greatest objection of all to fiat money is that it teaches people to believe lies. It creates the belief that the government can make money—that is, real, not representative, money—than which a more damaging lie never gained lodgment in the human brain." This is true, but it is an incomplete statement. A still more damaging influence which must be charged against fiat money, is that it teaches people to believe that the banks should not be permitted to issue representative, or paper, money.

The belief is wide-spread throughout the United States that the privilege of issuing money is a very valuable one ; that the banks are anxious to secure and control it for their private profit ; and that the Government should protect the people against the "soulless money changers" who design to charge a profit for the use of what should be "the people's money." Of all the stupid fallacies that have ever gained currency surely this is the most senseless and the most damaging.

As a rule a bank's capital and surplus are about represented by the cash reserve which is necessary to a safe business. Hence it follows that banking income and banking profits are derived almost wholly from deposits, which are loaned-out at interest. In proof of this I need only cite the fact that the aggregate deposits, of our national, state, and savings banks at present average about $4,250,000,000, while the national bank notes now in circulation amount to less than $200,000,000. If the greenbacks ($346,600,000) and the Treasury notes ($152,600,000) were immediately converted into national bank currency, the aggregate of bank circulation would still be less than $700,000,000,—or practically one-sixth part of the vast sums of money which the people gladly commit to the care of the bankers, to be used for their individual profit, in return for the security, the accommodation, and the convenience which the banks afford.

This is so simple and so obvious a demonstration of the source of banking profits that one marvels at the widespread popular notion that bankers are eager for the privilege of issuing money, and that such a privilege should be denied them. The truth is that for years past our national bank circulation has been declining in volume because it is unprofitable to the banks ; and under any possible or approved system, the necessary outlay of capital to provide security for the notes, and the cost of supervision and insurance against loss, must make the net profit on bank circulation a very slender one at best. But the issue of money is a natural and indispensable feature of a sound banking system, for the essential reason that the people make known their money requirements through the banks. The banker is, therefore, the only man in a position to decide promptly and intelligently as to whether or not money is required for legitimate business transactions ; his self-interest will induce him to supply it when needed by responsible borrowers ; the cost of issuing it will force him to retire it when no longer needed ; and not until we secure this automatic adjustment of currency issues through the banks, can we hope for that even course of business which is so indispensable to peace and prosperity. As Mr. Horace White has so aptly said : "The redemption of fiat money is always liable to contingencies. The government may not be *able* at all times to redeem it. The government may not be *willing* at all times to redeem it, in which case it cannot be coerced, or fined, as a bank may be for similar default. The national honor is a very poor substitute for the sheriff and his posse, to keep specie payments going."

To the student of the subject who has no selfish interest to serve and no pet theory to uphold, the way is so plain that he cannot go wrong ; and to the man who knows the American people and has learned their sterling honesty, their love of country, and their ardor for the right, there can be no fear of the final issue. Time and teaching are the needful things, and the leason to be learned is so simple that it can be written in a few sentences :

Retire the government's fiat money, which acts as "an endless chain" in depleting the Treasury gold reserve ; make it possible for the banks to issue currency at a slight profit above the known cost ; require each of the banks, instead of the government, to redeem its own notes in gold on demand ; and finally, give national banks the right to establish branches wherever they may be needed. Do these things, and the people will have made a bargain with their bankers the benefits of which will be simply incalculable !

THE SCOTCH SYSTEM OF BRANCH BANKS.

By J. Selwin Tait.

IN a recent letter to the press I used an argument in favor of branch banks which I may be permitted to repeat. "To the uninitiated it may seem a matter of small moment whether the country's banking is done by several thousand separate institutions—national and State—or by a small number of banks with a large number of branches, provided that both systems are equally safe ; and yet the independent bank of one roof and the many roofed or branch bank are so widely different in their results that the change from one to the other would mean the releasing of hundreds of millions of dollars of cash reserves, and might be made to mean the changing of our New York money market from a European plaything, knocked hither and thither at London's behest, to a great financial potentiality, which in its turn could make a bold bid for the financial supremacy of the world.

"In wealth the United States is not exceeded by any European country ; but its money lacks the power of concentration as well as the mobility which gives London the monetary control of the globe. If one could imagine Niagara's flood scattered all over the country in innumerable lakes and ponds, and left to find its way to the ocean through ten thousand little rivulets, instead of uniting its waters to form a force sufficient to turn every wheel on this continent, that would form a scarcely exaggerated example of the difference between capital divided among thousands of independent banks and capital united and mobilized under the branch system."

Under the national bank law the large concerns in New York and other reserve cities are required to keep twenty-five per cent of their capital as a cash reserve. Similar establishments in London, which act for country banks in much the same capacity, keep about ten per cent. less cash reserve than our national bank laws require. In this country we have 3,712 national banks with deposits of $1,715,000,000. These banks are compelled by law to keep from fifteen to twenty-five per cent. of their deposits in cash, so that the less elastic system keeps needlessly in idleness a considerable portion of the country's capital.

If the country banks which withdraw from the leading cities the many millions of dollars necessary to handle the crops each fall were simply branches of large institutions having their chief offices in central cities, a smaller proportion of cash reserve would be necessary than is made obligatory, and thus millions now lying idle would be available for agricultural, commercial, and industrial enterprise. Funds accumulated during the winter and spring and summer by the central offices of these banks and shipped to outlying branches in the fall to be divided among hundreds of thousands of people interested in agriculture directly or indirectly might be compared to a rainfall which fills the streams, then the rivers, and eventually reaches the sea, whence by natural action it again becomes transformed into rain.

A forcible illustration will be found in a comparison of the average amount of capital and surplus of each national bank with that of each English branch bank. The 3,712 national banks of this country have an aggregate capital and surplus of $903.000,000, or an average of $240,571 per bank. Taking the ten joint stock banks of London which have the largest number of country branches, it will be found that they have a combined capital and surplus amounting to $99,366,250. This total divided by their number of branches (1,343) gives $74,000 of capital and surplus to each branch. From this comparison it is clear that, were the same amount of working capital and surplus employed under the branch system, it would be sufficient for 12,127 banking establishments instead of 3,712. It is, therefore, apparent that we have sufficient banking capital already in use *to increase the number of our banking establishments three hundred per cent.*, if employed under a proper system; or, to put it in another way, in consequence of the cumbrous and antiquated character of our banking methods, we have in our national banking institutions more money than is necessary by $628,312,000.

As this comparison of the respective amounts of capital and surplus employed by the English banks and our own national banks is a very important one, I think it only right to give a list of the English banks embraced in my figures. Any one familiar with the subject and examining this list will admit that it includes only those banks which best represent the idea of a central office in London with branches scattered over the country.

Name of Bank.	No. of Branches.	Capital. £	Reserve fund or Surplus. £
Capital & Counties Bank	184	932.000	722.000
Lloyds	195	1.780.000	1.000.000
National Provincial	172	3.000.000	2.000.000
Williams, Deacon	64	1.000.000	440.000
National	105	1.500.000	290.000
London & County	177	2.000.000	1.000.000
London & Midland	142	983.000	700.000
London & So. Western	101	600.000	250.000
London & Provincial	137	500.000	605.000
Parr's	66	500.000	71.250
	1,343	£12,795.000 or $63.975.000	£7.078.250 or $35.391.250

A comparison with the State banks is much less striking, as these average only $88,419 in capital and surplus; but, compared with the branch banks, even these lock up in the aggregate $53,483,892 more than is necessary. Adding together the capital and surplus needlessly locked up by the national and State banks, and the excessive reserves which the system of isolated banks renders imperative, we have the astonishing spectacle of a country which needs every dollar of its capital locking up $750,000,000 more than is necessary in one form of business alone. Such a condition of affairs is a reflection upon the intelligence of our people.

The national banks of this country number 3,712, and the State banks 3,586. Here, then, is the spectacle of 7,298 independent banks, without cohesion or combination, but each determined, on the first appearance of danger, to save itself at whatever cost to the others or to the community at large. Although we have the object lesson of the New York Clearing-House banks uniting in mutual support during troublous times, there is virtually no standing shoulder to shoulder in this vast army to resist an onslaught; and there cannot be, because, after all, each bank is a purely local and isolated institution, equally so in its sentiments as in its depositors and stockholders. And this consideration brings to light another danger.

By far the larger part of the capital of our national banks is held in the vicinity where the bank is located, so that a local depression which endangers the bank threatens a double blow,—first to the depositor, and then to the stockholder,—and so precipitates the danger of a panic. In order to illustrate how immensely superior the branch bank system is for country places subject to depression and consequent danger, I would say that I could name banks of the kind, in London and in Edinburgh, which *could each lose the total assets of a dozen of their country branches and never pass a dividend.* Will any one say that the existence of a branch of such a bank in a town would not be a tower of strength and a restorer of confidence in times of peril?

Of course it is not to be supposed that any banking scheme would be entitled to a moment's consideration which would endanger the safety of national or State banks with deposits amounting to $2,373,000,000. The branch system, if introduced to-morrow, would begin its work very gradually, and would take its place in the banking economy of the country without any disturbance or dislocation of existing conditions. Wherever the branch of a strong bank was placed, it would be at once a source of confidence as an earnest of outside help when needed. In this way the system might make considerable progress in times of depression, but at first its progress would be slow.

Joint stock banks with branches were started in England upwards of sixty years ago, although Scotland had them long prior to that period. When these branches first made their appearance, England was covered with private banks of influence and wealth. These banks, for the most part, had been in existence a great number of years, their owners were usually the most respected members of the community, and, as a whole, the people—the most conservative in the world—believed in them like a creed. It seemed almost hopeless to expect that country people, with whom "confidence is a plant of extremely slow growth," would deposit their money with institutions which must have seemed to them new-fangled, and which were without any of the local influence and character of the home bank; yet what is the result? After the lapse of half a century the branch banks of England have absolutely swallowed up the whole private banking system, one bank alone having absorbed between three and four hundred. The success of the branch bank is simply the survival of the fittest.

London is to-day the center of domestic, colonial, and foreign banks with branches whose deposits are considerably in excess of $5,000,000,000, and this enormous growth is, with the exception of Scotland's share in it, very largely the outcome of the branch bank system during the last fifty or sixty years. Not only has London's monetary position been greatly strengthened by the change in England's banking system, but every city and village in the country has benefited by her gain. In fact, the whole country, but especially the English metropolis, has gained weight and prestige through the change in the banking system, which has meant the mobilization of practically every coin in the country, and—what is far more important—an increased stability in her credit. The knowledge that all the money of the country is within instant reach and can be sent promptly hither and thither as occasion may demand, is a source of continual confidence, and that confidence has made the gold sovereign of England to-day the basis of the most stupendous pyramid of credit the world has ever seen. The enviable position which Great Britain holds as the money center of the world is the logical outcome of her improved banking system.

Simultaneously with the development of her banking along the most intelligent lines, England gave much attention to the framing of the Companies' Acts regulating the formation of investment incorporations, and safe-guarding as far as possible the investor, so that the influences which attract capital and confidence to London should not be made the means of injuring her vast army of small capitalists. The result is that to-day London is practically the investing center of the entire British Islands, and there is not a single stockholder in the United Kingdom whose name and address is not on file in the brokers' offices in London. In this way the English metropolis is not only the receptacle of enormous accumulations of capital, but the distributing point as well, and this is why London's voice is so potential on our own exchanges to-day. She speaks for all England. In the way they have handled their opportunities Great Britain and this country afford respectively an interesting study of how to attract capital and investors and how not to do so.

As regards the safety of branch banks, it may be said that a failure among English joint stock banks with branches is so rare that such a catastrophe may almost be said to be unknown.

In point of profitableness it may be pointed out that the capital stock of the banks named stands at an average premium of over 250 per cent., and, although a considerable liability attaches to their shares, they are in such good repute and the market for them in the financial centers is so assured that they yield less than 4½ per cent. at the market price. Before passing from this question of profitableness, it may not be amiss to refer to the enormous advantage which a stockholder in a large bank with its chief office in the money center of the country—thereby having a wide market for his stock—has over the holder of shares in a local bank limited to a local market and subject, not only to local vicissitudes, but also to lack of funds to buy.

In the case of the ten banks named, the stockholders number 51,629. These are scattered over the entire country, so that whatever risk there is is widely scattered and in no sense local.

The expenses, all told, of conducting such establishments are less than one and a half per cent. per annum of the amount due their depositors. In the case of very large banks with few branches the expenses are still less ; thus, in the case of the London and Westminster Bank, with only seventeen branches, all of which are in London, and deposits amounting to $130,759,670, the annual expenses are less than one per cent. of the total amount due depositors.

A bank with branches has an immense advantage over its isolated rivals, in that it offers to its customers exceptional facilities for conducting business with cities where it has branches ; and, in the case of a moving population, it gains depositors at every turn, since a new arrival in a city naturally gravitates to the branch of the bank he has known in his own town, even if he did not do business with it there.

The many-roofed bank meets the business man wherever he goes, and its very ubiquity engenders a confidence which helps credit very largely. Take the case of a new town where no bank has previously existed, and where there is not a cent of unused capital with which to start one. Let a bank, long and honorably known in a hundred cities, open a branch there without taxing the inhabitants for a dollar of capital, but, on the contrary, with the offer of such financial assistance as their business justified, and the establishment of such a branch, which in the worst times of danger would be felt to be as strong as its powerful parent establishment, would be a great stimulus to confidence and a source of an immensely-increased business. Multiply such a branch bank a thousand-fold throughout the newer sections of the country, and it is difficult to estimate the good which would result to business.

When the branch idea, or "agency," was in its infancy in Scotland, that country was the poorest on the face of the globe. For a great many years the entire country has been covered with branch banks or agencies, and to day Scotland boasts ten banks with a thousand branches and justly claims that, *per capita*, she is the wealthiest country in the world, although her climate is as bleak and her soil as niggardly as when she was the poorest. Scotland owes no small part of the change to her banking system, if indeed she does not owe it all. In the hands of a thrifty, honest people her banking cash-credit system worked out through the banks' agencies was a Godsend to the country at large, and was the finest exemplification ever seen of the power of credit in developing commerce and inducing wealth.

The actual expenses of conducting branch banks are relatively small compared with those of independent banks. There is neither president or board of directors for the local establishment to provide for, the business being conducted by a manager and staff. The manager of a branch bank is supreme under his own roof, and would not be out-ranked by any president of a competing bank. In England it was originally the custom to choose bank managers from the most influential men of the town, but the practice was abandoned long years ago, and now they are selected from among the bank's ablest officers. They are invariably men of culture and address, and of good business training. They are much more likely, from their experience in large cities, to be able to answer the business questions which country bank customers ask of bank presidents and cashiers than the president whose knowledge is more local. The branch bank system is a death-blow to nepotism in making up the office staff. Each officer of the new branch is a well-trained official from the chief office, and, if he has no local sympathies or affinities, he has at the same time no antipathies. The discipline is military in its strictness, and, as stated, there is no kinship among the officers to induce looseness in supervision or undue leniency towards irregularities.

Boys who enter such a bank are understood to have decided upon banking as a career, and, as a rule, they follow that profession until they are comfortably pensioned off. There is no doubt that the pension as an institution is the very soundest policy. It makes the official content to work for a moderate salary, since his future is provided for and the fear of endangering it doubles his carefulness. Men inured to the handling of money from their earliest youth, and taught above everything the sacredness of banking money, are little apt to tamper with the bank cash in after life. Still, no risks are taken, and in the branches themselves and on the part of the head office the most rigid system of inspection conceivable is carried on, with the result that the great branch banks of England with chief offices in London—and these I consider to be the most perfectly managed banking institutions in the world—have suffered no appreciable loss from the defalcation of an employee for upwards of thirty years,—a wonderful record, it will be admitted, when the experience of our own banks is taken into account.

In the advantage to be derived from a simple and uniform system of bookkeeping in all the branches, in the bank's ability to locate its branches so that a superfluity of deposits at one center will be offset by the special demands of another locality, and in a variety of ways too numerous to refer to in a short article, the branch bank has an advantage over its rivals.

If it be feared that the branch bank system would cause a dangerous concentration of capital and monetary power in the large cities, it may be replied that the same kind of argument could have been used for forbidding the building of trunk lines, on the ground that, by furnishing undue facilities for travel, they were calculated to remove our country residents into our cities, and so concentrate population there. Instead of this, railway trunk lines have been the only possible agents for the adequate opening-up of the country. And so it is with the branch banking system. It mobilizes the country's capital, and maintains that regular ebb and flow of money between the large cities and country towns which the exigencies of both demand. Indeed, it is apparent at this late hour of the nineteenth century that, instead of such establishments having an undue weight in the large cities, an influence of the kind might be advantageous to balance the over-preponderance of capital, and the power it represents, now in the hands of certain private bankers. We have recently witnessed a spectacle of the kind, in which it seemed for a time that a single private banker of the city of New York could practically dominate all the banks of the country and virtually control all the available gold,—a most undesirable condition of affairs, which does not exist in any other great country.

Space forbids me to say more, but I think that any dispassionate reader, after studying the claims of the branch bank system here advanced, will agree that, when President Cleveland recommended the formation of branch banks in his last message, he did an eminently wise thing.

PROFESSOR RÖNTGEN'S DISCOVERY OF A NEW RADIANCE.

By Michael I. Pupin.

RÖNTGEN'S discovery of what appears to be a new form of radiant energy has justly atracted universal attention. The interest attached to it is a twofold one: first, its purely scientific significance; second, its practical importance. The discovery may be stated broadly as follows: if an electric current be sent through a vacuum tube—the so-called Crookes tube,—then, in addition to the heat and fluorescent light generated in the glass of the tube, there is, according to Röntgen's discovery, another form of radiant energy generated, which we may call the Röntgen rays. The following characteristic elements describe this energy: it produces fluorescence in fluorescent substances, just as ultra-violet light; it affects the photographic plate, just as the actinic part of the solar spectrum; it penetrates all bodies, even the metals, in a greater or smaller degree, and it is neither reflected or refracted appreciably. No other known form of radiant energy resembles the Röntgen rays in this last respect.

Much has been written lately about this discovery, but little has been said which would serve as trusty and intelligible guidance to those who are not familiar with modern electric appliances. It seems desirable, therefore, to give here a brief and simple description of the apparatus, and of the method of operation.

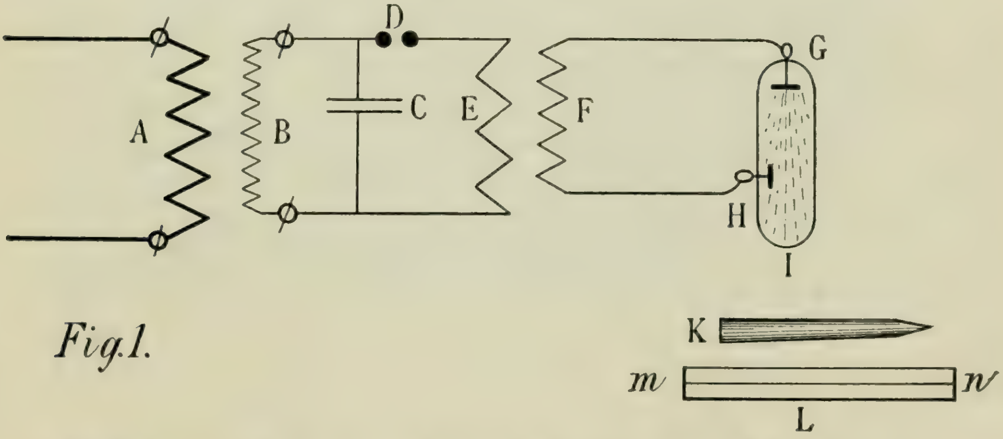


Fig. 1.

In Fig. 1 we have an ordinary induction coil, AB. Its primary coil, A, is connected to the mains of an alternating current circuit, and the supply of current is regulated by an auxiliary resistance-box. The secondary winding, B, is connected to a Leyden jar, C. A gallon jar with a medium-sized coil gives a sufficiently strong effect. The jar is connected to an oscillatory transformer, EF, which needs a more detailed description. It can be constructed as follows. Take two large glass jars, A and B (Fig. 2); wind about eighteen turns of very coarse, well-insulated wire, aa, on the outside jar, B, and about two hundred turns of fine wire, bb, on the inside jar. Place the jar, A, into B, and fill the space between them with very hot paraffin. Pour very hot beeswax over the outside winding, aa, until a thick crust is formed. This is then an oscillatory transformer. The coarse wire winding, aa, is the primary, and the fine wire winding is the secondary, of this transformer. In Fig. 1 the primary, indicated by E, is connected to the Leyden jar, C, and the secondary to the vacuum tube, GH. The plateholder, L, containing the sensitive photographic plate, mm, is in line with the electrode, G, so that it is in the line of discharge from this electrode. The object, K, to be photographed, is placed between the tube and the plate.

Fig. 2.

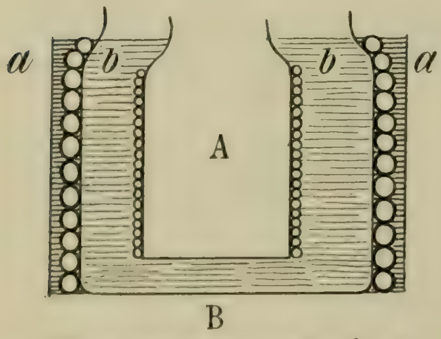
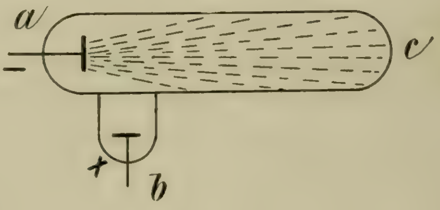
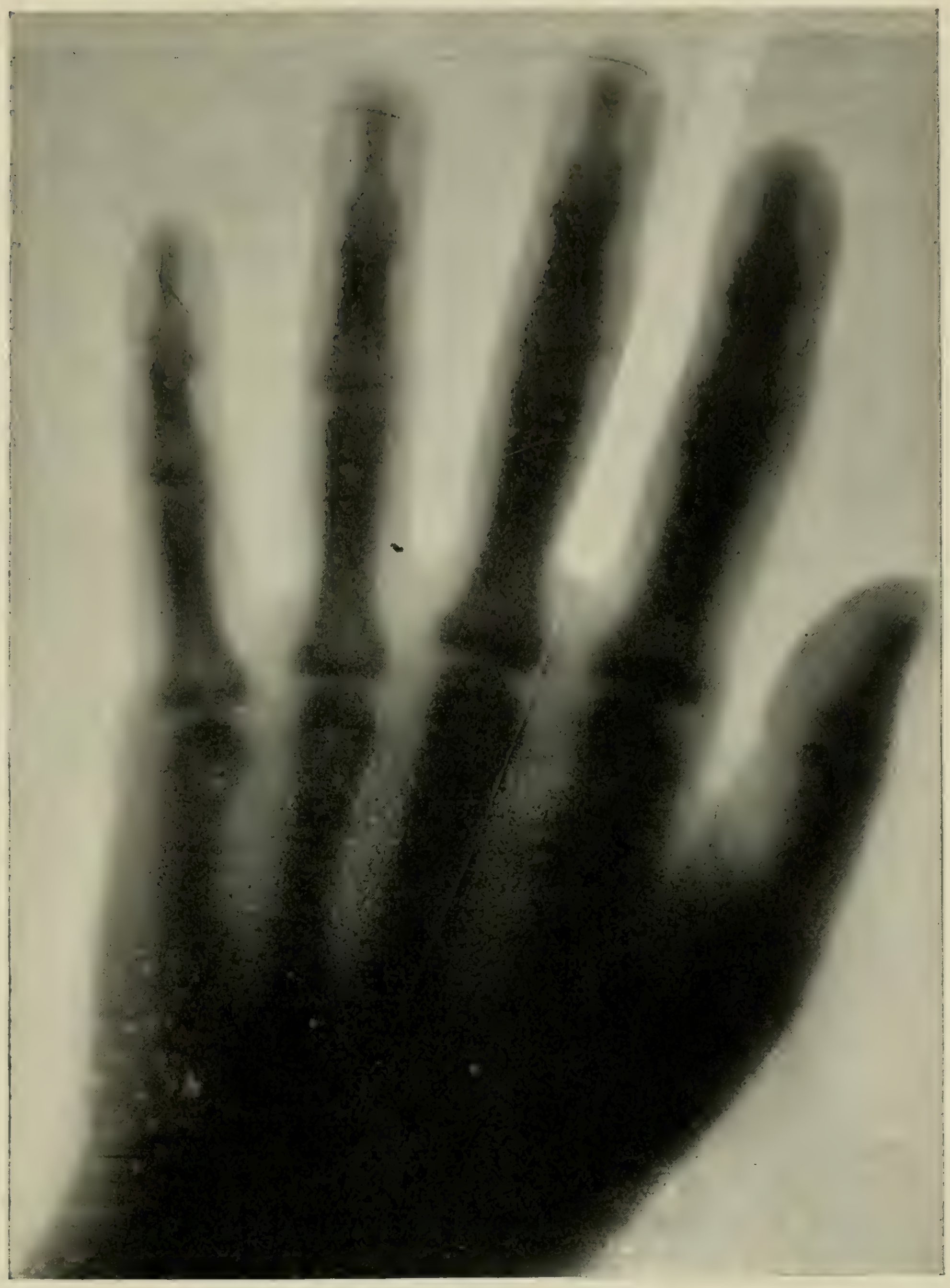


Fig. 3.



We can pass now to the operation. Observe first that the circuit, CDE, contains an air-gap, D, between two small brass spheres. As soon as the current is admitted into A, there is induced a very high tension current in B, which charges the jar until the tension between the small spheres of the air-gap is high enough to break through. The jar discharges then, and the discharge current will oscillate back and forth in the circuit, CDE, at a rate of several hundred thousand vibrations per second. These vibrations die out rapidly, but the alternating current in B makes a break through the gap, D, at every alternation, and sets up, after each disruptive break, a series of oscillations. In fact, the circuit, CDE, may be compared to a church bell, and the disruptive action at the gap, D, performs the function of the swinging tongue of the bell. After each stroke, a series of waves spreads out into space,—melodious sound waves in one case, silent electric waves in the other. These rapidly-vibrating waves induce in the secondary circuit, F, a series of waves of the same rapidity, but of much



HAND TAKEN BY M. I. PUPIN.

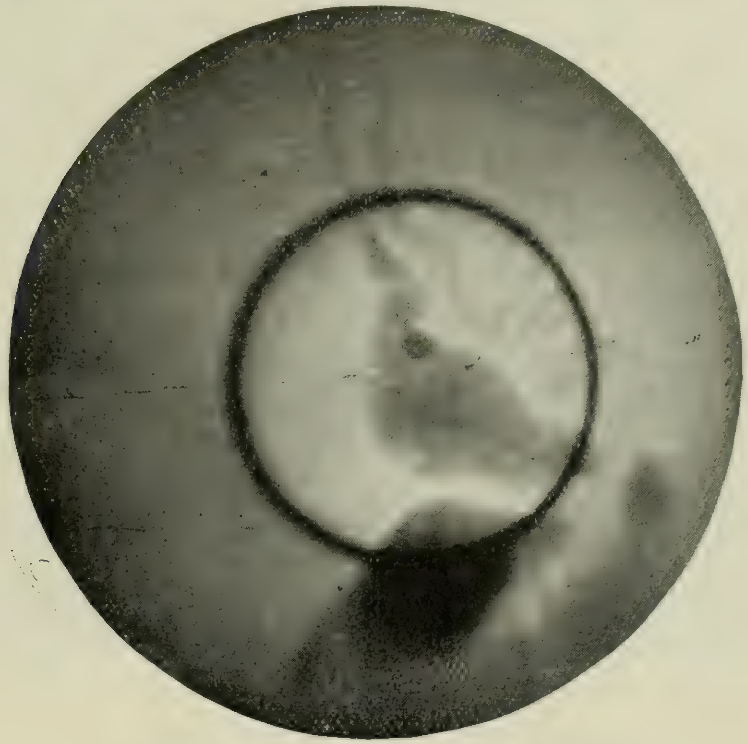
Employing a Holtz Machine and a Crookes Tube. Time of Exposure, 50 Minutes.

higher tension. The oscillatory current in the tube, GH, produces a luminescence in the attenuated gas in the vacuum tube. If the vacuum is not very high, the luminescence is almost entirely within the gas itself; this is not the case in very high vacua. For the purpose of pointing out clearly how these Röntgen rays are produced, it is well to consider briefly the electrical discharge in the tube when the vacuum is very high.

Fig. 3. represents a typical form of a vacuum tube, capable of giving a strong Röntgen effect. Two platinum wires, a and b, carrying aluminum discs, are sealed in a glass tube. They are the electrodes which are connected to the high tension coil. The electrode which at any moment is connected to the negative pole is called the cathode, and that connected to the positive pole is the anode. When the current is oscillatory, as in the arrangement described in Fig. 1, each electrode alternates periodically between being anode and cathode. Thus, in an alternating current reversing one hundred times per second, each electrode will be anode fifty times and cathode fifty times per second. Fix, now, any moment when a is the cathode and b is the anode. Suppose that the air pressure in the tube has been gradually reduced by the action of a mercury pump to something like one millionth of an atmosphere. The electrical discharge, which, as long as the vacuum is not high, appears as a bright luminescence of the gas, is hardly visible at this excessively low pressure.

In place of this luminescence of the gas, there appears in very high vacua a vivid fluorescence of the glass,—blue in American glass, green in German glass. This fluorescence is produced by faint streamers which proceed in straight lines from the cathode, as indicated by the dotted lines in Fig. 3. Where these streamers meet the tube, there the fluorescence and the heating of the glass take place. Professor Röntgen finds that this brightly-fluorescing surface in the walls of the tube is the seat of a radiant energy, which possesses the characteristic features described above. These rays, which Röntgen calls the X-rays, can be observed in a dark room by means of a paper screen saturated with an emulsion of a fluorescing substance. The discoverer employed barium platino-cyanid. Wherever the rays strike this screen, they cause it to fluoresce, and the intensity of the fluorescence measures the intensity of the Röntgen rays. By interposing a substance between the tube and the screen, the relative opacity of the substance for these rays can be determined. It is found that even metals are transparent to it, but in various degrees. Thus, if a given thickness of platinum will absorb a certain amount of these rays, it is found that the same amount of absorption will be produced by a lead plate of three times the thickness, by a zinc plate of six times the thickness, and by an aluminum plate of two hundred times the thickness. Wood, ebonite, rubber, water, and organic compounds, are more transparent than metals, but none of them are perfectly transparent, nor is any substance perfectly opaque. A fact deserving an especial mention is that glass, especially that containing lead, is nearly opaque. Bone is much more opaque than flesh; the shadow of a human hand on a fluorescent screen will, therefore, show the skeleton darker than the flesh.

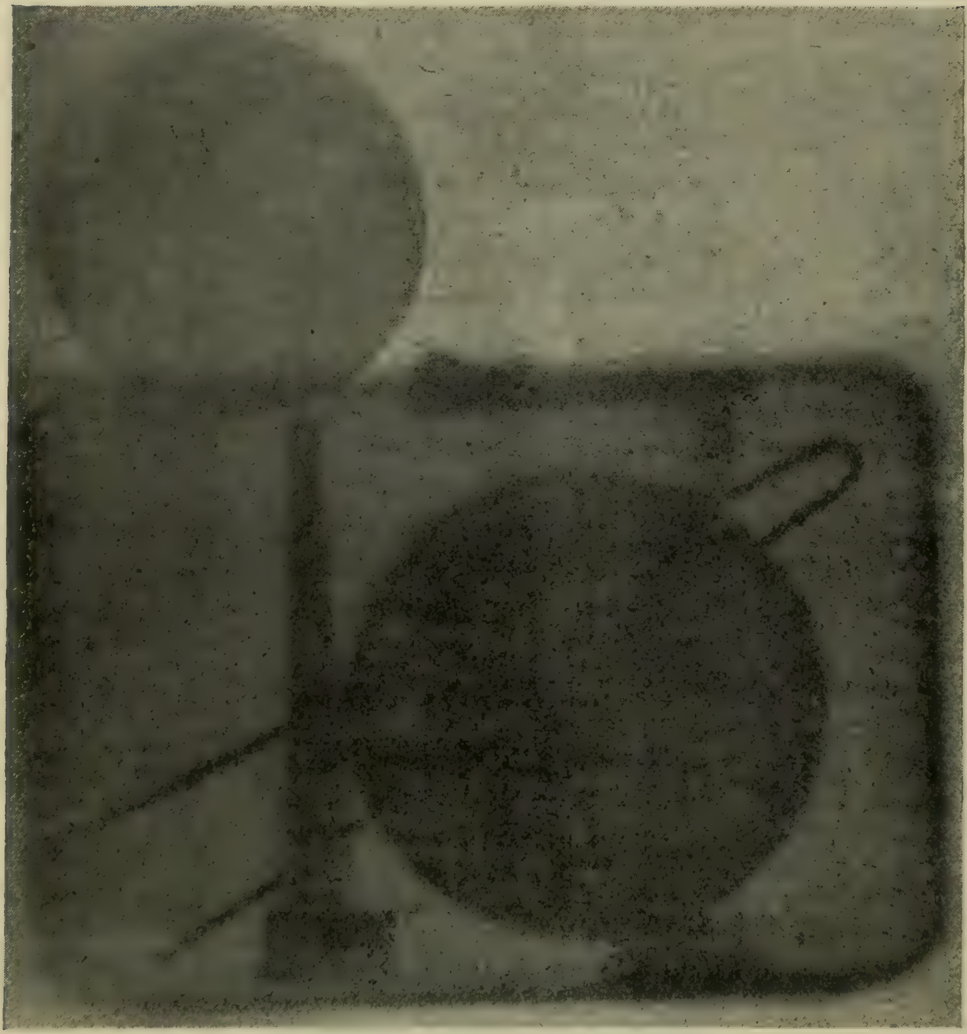
Another method of studying this new form of radiant energy is by means of photography. Röntgen found that a photographic film is affected by the X-rays, but, since these rays are neither reflected or refracted, it is useless to employ lenses. The plate remains shut up in the plate-holder, and the object to be photographed is placed upon it, so as to be between the tube and the plate, as indicated in Fig. 1. The time of exposure varies with the quality of the vacuum and the electric tension employed. It may be as short as four minutes, or it may be as long as two hours. The nearer the tube is to the plate, the shorter is the time of exposure, but evidently the less defined will be the shadow picture. There is good prospect of perfecting both the means of producing the vacua and also the construction of the tubes, so as to produce the X-rays in a larger quantity. This would shorten the time of exposure, and also improve the definition of the photographs.



AN ALUMINUM DISC WITH FIGURES IN RELIEF.

The negative shows much detail and also want of homogeneity in the metal of the upper plate above the crest of of the bird, the plate being less transparent in this part than in the lower part. Taken by M. I. Pupin with a Holtz machine and an electrodeless tube. Time of exposure, 25 minutes.

Röntgen's experiments have been repeated in this country in several laboratories,—at Harvard, Yale, Johns Hopkins, Princeton, and



ALUMINUM BOX CONTAINING AN ALUMINUM MEDAL AND HAIRPIN.

Under-exposed. Taken by M. I. Pupin.

in the writer's laboratory at Columbia. At the McGill University in Montreal a bullet was located in a man's leg by means of this photography. Similar reports have reached us from Europe. Several hospitals in this city intend to put in an outfit suitable for the production of the X-rays. The surgeons expect much help from this remarkable discovery, and the experimental results obtained in this country so far seem to hold out a very bright prospect.

But surgery is not the only profession which is going to reap the immediate benefits from the practical application of this discovery. Metallurgy and mineralogy expect to overcome some of their old difficulties with the aid of the X rays. Various minerals have a various degree of opacity for these rays, and it is not at all difficult to distinguish a real gem from an imitation. The occlusion of metals is particularly easy to detect, since metals seem to be more opaque than other substances. But even the metals themselves have a various degree of opacity, as has been already pointed out. Hence, if two metals are mixed to make an alloy, and the mixture is not perfectly homogeneous, it would be an easy matter to detect the want of uniformity, provided, of course, that a sufficiently thin plate is cut from the sample to be examined ; thick plates are too opaque to permit an appreciable part of the X-rays to pass through. It is, therefore, not quite clear to the writer how this new method of photography can be employed in its present stage of development to detect flaws in steel guns and armor plates, unless these rays are made much more powerful than we have been able to make them so far, and unless also we discover photographic plates which are much more sensitive to these rays than the plates now in the market. The author confesses his belief, however, that we shall, in all probability, soon reach both these improvements. A sufficiently long exposure will, even now, as the writer knows from his own experiments, reproduce the various details in the structure of a body. So, for instance, the photograph of a pair of spectacles in a leather case and separated from the plate by a thin sheet of ebonite will, with sufficiently long exposure, show the curvature of the lenses. The photograph of an aluminum medal will sometimes come out so neat and well-defined as to show the lettering and the figures,—that is, in the negative. In the printing this fine detail is not always clearly shown. But it must be remembered that we are only at the beginning of a new art. We hope, and with reason, that this new photography will reveal the interior structure, not only of dead matter, but also of living organisms.

The photographs accompanying this article explain themselves.

Since writing the above I have been able to collect additional facts which seem of sufficient interest to merit mention.

The apparatus described above was discarded as too complicated and too severe on the tube. A six-plate Holtz machine made by the Galvano Faradic Company of New York was tried and gave complete satisfaction. The Röntgen effect with such a machine is sufficiently powerful, and the wear on the tubes is small. In fact, they seem to improve with use, instead of deteriorating. The tube should be connected in series with the outside coatings of the two jars, and the capacity of the jars should not be too large for the size of the tube. With a pear-shaped Crookes tube of 5 inches diameter half-pint jars give excellent results. A cylindrical vacuum tube without internal electrodes, but with external tinfoil coatings at the extremity of the tube, will do very well as a substitute for a Crookes tube. The vacuum should be as high as anybody can possibly obtain. This is one of the good things of which we cannot have too much,—at least with the methods of exhausting now employed in this country. It should be observed that these methods are perfectly wretched.

Regarding the detail of the things photographed, it is important to observe that Röntgen photography acts differently from ordinary photography. We cannot speak here of over-exposure, unless we specify that it is over-exposure with regard to certain parts which are exposed. Take, for instance, the shadowgraph of a number of objects enclosed in an aluminum cigar box. With a short exposure the details of the structure of the box appear, but those of the enclosed objects do not. With a long exposure the box itself is almost invisible, but the details of the enclosed objects appear. A still longer exposure will make the things enclosed in the box disappear one by one. The most opaque will remain longest. Again, consider the photograph of the human hand. A short exposure gives nothing but the flesh. A little longer exposure brings out the nails. Still longer, and the skeleton begins to appear, whereas the flesh begins to disappear. Still longer, and nothing but the bones appear the various parts being accurately represented in their relative opacity. A still longer exposure will make the various parts of the skeleton disappear one by one, according to their relative opacity. A sufficiently-prolonged exposure would reveal opaque objects concealed in the bone itself. There is no doubt that by a sufficiently long exposure the homogeneity of not excessively thick metal plates can be examined with considerable accuracy.

M. I. P.

February 18, 1896.

THE RAILROAD FACILITIES OF SUBURBAN NEW YORK.

By Foster Crowell.

"NEW York is full of Indians," I heard a sailor-man say in a cable-car the other day. "I've seen heavy weather," he continued, swinging on his strap—"the life-line," he called it—as we were hurled in several new directions at once, "but never nothing to lay over this; there ain't no civilized people lives here."

To say that New York is not civilized in this regard is to imply that somewhere there exists a satisfactory metropolitan transit system.

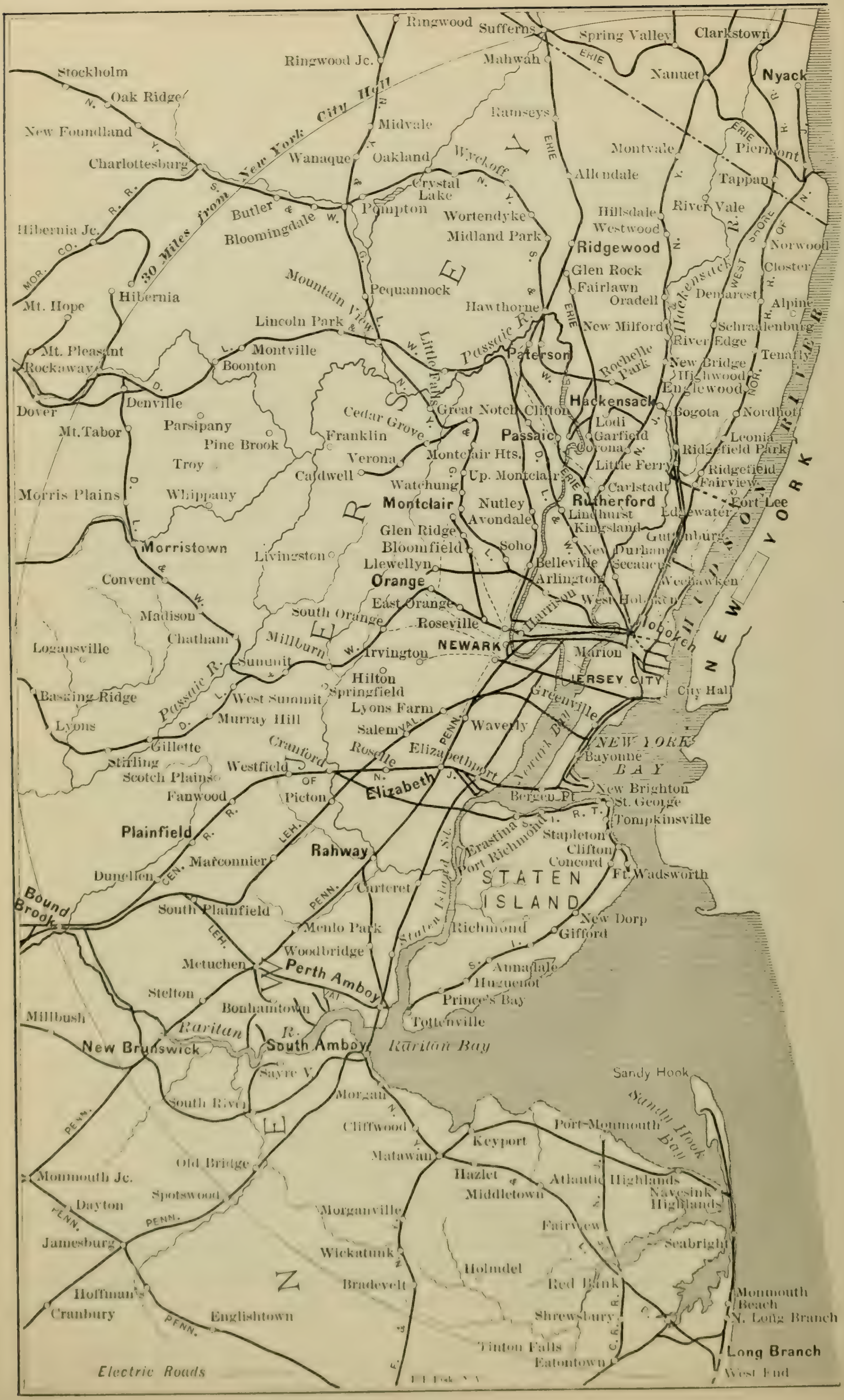
It is questionable whether a broad statement like that would pass unchallenged in application to any place. The London arrangement is very convenient for its enormous general suburban traffic; and yet it comes far short of an ideal system. Certainly it leaves much to be desired from our point of view; but it will be worth our while, presently, to examine it briefly as a starter, so decidedly is it in advance of anything we have in the United States.

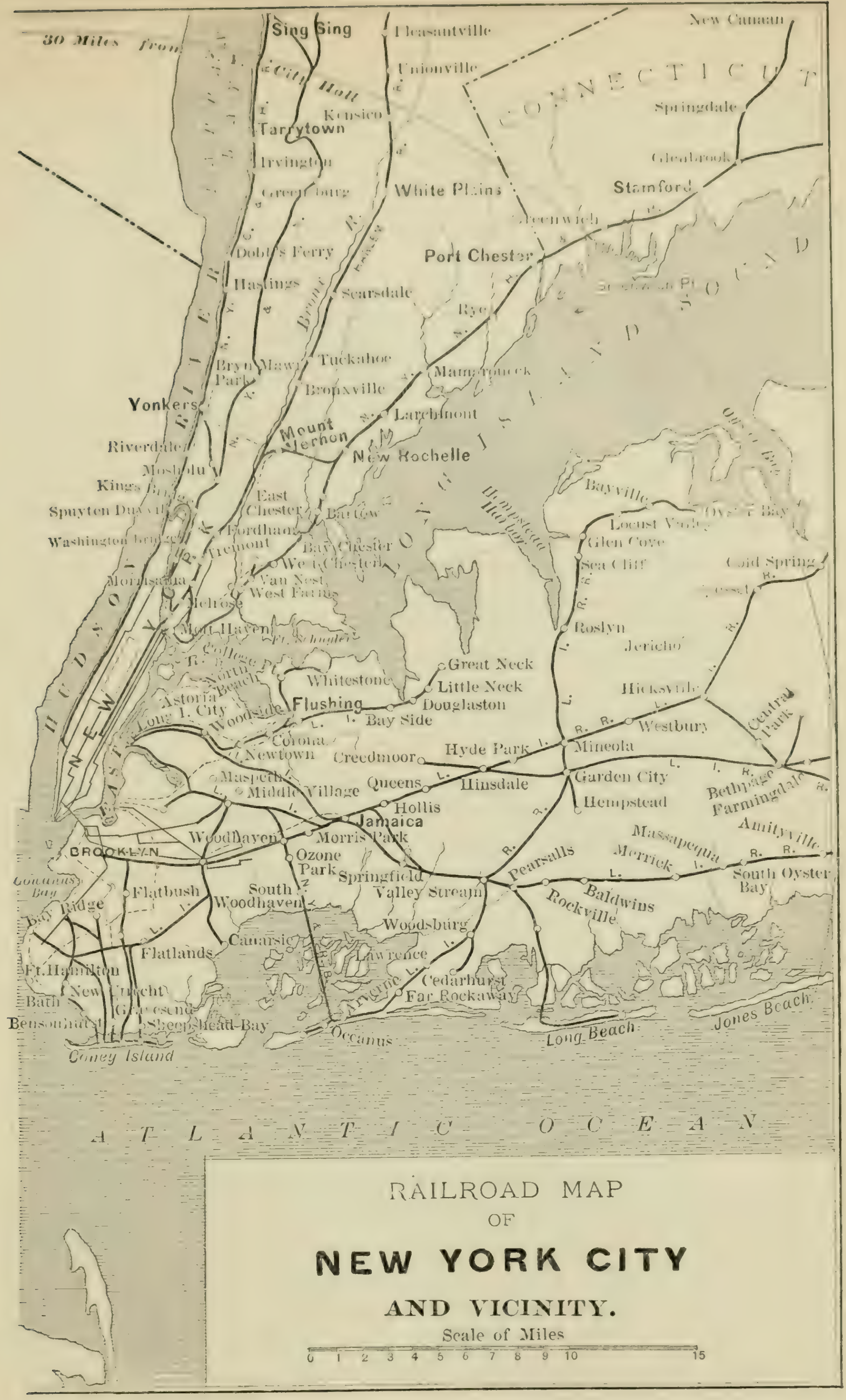
But first let us see where we stand.

It is perhaps a misnomer to speak of the suburban railroad as a problem; it would be more accurate to consider it as an evolution in progress. Suburban traffic has grown up chiefly along the main stems of the railroads that were projected for interurban business only, often without thought of the former. Of course, on some of the lines where the suburban development has been most marked considerable attention has been bestowed upon it; and, so far as has been possible by local improvements, additional tracks, and more frequent trains, much stimulus has undoubtedly been given to the building up of suburbs. And this seems to be becoming more and more general. But the natural result has been that the development has taken place along narrow radial strips, extending out twenty-five or thirty miles, instead of in a more compact occupation of concentric belts. For the purpose of this article, a suburbanite is one residing within thirty miles of New York City Hall and coming to town regularly for business or pleasure. Thirty miles has been selected as the radius vector for two reasons; the first being that it just takes in all the important towns and villages that depend chiefly on New York; the second that, with improved facilities of transportation, it seems likely that all except obviously undesirable country within the thirty-mile circle will become thickly settled before much suburban occupation takes place outside of it. Into this question the element of time spent in the daily journeys enters largely, and there are other natural controlling causes. The existence of attractive nuclei already established on the farther confines of this territory will have an important effect upon the distribution of new population, which otherwise would now tend to concentrate nearer the city. Sketching it roughly, the thirty-mile circle touches Bound Brook and Morristown on the west; Stamford, Oyster Bay, and Babylon on the east; Tuxedo and Sing Sing on the north; Long Branch and New Brunswick on the south. Its full area is twenty-eight hundred and twenty-seven square miles; deducting the areas of New York, Kings county, Jersey City, and Hoboken, as well as the areas of water surface and ground unsuitable for human habitation, there remain not far from fifteen hundred square miles. How much of this will be strictly suburban can only be guessed at. A considerable portion of it will be urban in many respects,—as Newark is, for example; but Newark is largely dependent on New York, and a large percentage of its population do business in the metropolis. Let us assume that eventually sixty per cent., or nine hundred square miles, will be occupied for residential purposes.

We must now guess again as to the probable density that a suburban population will attain. This is a question of some difficulty, but it may be solved approximately in several ways. For one way I have taken the present condition of the Oranges as about the average, or normal, of all the suburban territory of the future; this does not mean that either the city of Orange or the township of East Orange has stopped growing, but merely that the combined population of all the Oranges has about reached an average suburban density. This, of course, is largely a matter of opinion, but will serve as an illustration. We find that there are, on the average, about five thousand people to the square mile. Multiplying this number by the number of square miles (900), we have four and a half millions for a hypothetical suburban census of the future. This is to be taken only as a crude approximation; there are absolutely no data on which to base either the rate of growth or the law of distribution. Suburban populations are sporadic, so to speak; they reflect the growth of the metropolis, but are not of it. If, by a miracle, real rapid transit should be secured for the outlying parts of the city, they would be built up at the expense of the further suburbs; whereas, if the railroads provide adequate suburban facilities, and if the rapid-transit question continues to be dealt with as of yore, the suburban development will be stimulated greatly, and will doubtless advance with increasing strides.

We reasonably may conclude that the suburban territory within the thirty-mile radius is ample for the development of very many years, and it is a region so diversified between the seashore on the one hand and the mountains on the other that it furnishes, besides abundant space for homes, most attractive resorts for health and recreation. In these natural advantages no modern city can compare with New York, but it remains for future enterprise to develop their dormant possibilities. We have to deal in this article with only one feature of the future development, as a basis for which it will be interesting to study the railroad map on pages 1032 and 1033. It is evident that there are already a sufficient number of main stems to serve a very large proportion of the entire area, provided adequate means of distributing the suburban traffic are supplied. Facilities are means of easily getting from place to place, and, if there are any New York suburbanites provided with them at present, they keep the matter to themselves. This does not involve lack of excellence in the railroads and their general service in other respects; but the fact is plain that in this particular respect it would be difficult to find a more poorly-served community. Despite the many radiating lines of steam roads and the rapidly-spreading electric systems, New York has no adequate suburban facilities, because of the difficulties of reaching the railroads themselves. For many years the New York Central & Hudson River Railroad has endeavored to persuade a somewhat skeptical public that it was the only one having a railroad station in New York city. This somewhat tiresome reiteration is literally true in a sense. Instead of others, we have the ferry terminals, the use of which by the suburban public involves an enormous waste of time, accompanied by discomfort and often by grave risks. Nevertheless, the ferries will continue to be used. Where New York has ferries, London has a cordon of vast terminal stations. In order to make the contrast clear to the general reader, I have prepared a map of New York below Seventieth street, and on it have imposed the circumference of an ellipse whose major axis is somewhat over five miles long and its minor about half that. The same ellipse placed upon the map of London, with its major axis running east and west instead of north and south, would inclose no less than eighteen terminal stations of all the railroads entering London, not counting the thirty-two stations of what is known as the "inner circle" of the underground railroad, which also lie within the ellipse. The great terminals of King's Cross, St. Pancras, Euston, Paddington, Victoria, Waterloo, London Bridge, and Fenchurch Street are situated upon the circumference of the ellipse, while Charing Cross, Ludgate Hill, Holborn Viaduct, Cannon Street, Broad Street, and Liverpool Street are close to its


Ringwood
Suffern
Spring Valley
Clarkstown
Ringwood Jc.
Mahwah
Erie
Nanuet
Nyack
Stockholm
Oak Ridge
N. Y.
New York City Hall
30 Miles from
Ramseys
New Foundland
Midvale
Montvale
Piermont
Charlottesburg
Wanaque
Oakland
Wyckoff
Allendale
Tappan
Crystal Lake
S. R. R.
Butler
Bloomingdale
Pompton
Wortendyke
Hillsdale
River Vale
Hibernia Jc.
Westwood
Midland Park
Ridgewood
Norwood
Mor. Co. R. R.
Closter
Glen Rock
Mountain View
Pequannock
Fairlawn
Hackensack
West Shore
Demarest
Mt. Hope
Hibernia
Hawthorne
Oradell
Alpine
Lincoln Park
New Milford
Schraalenburg
River Edge
Mt. Pleasant
Montville
Passaic R.
Little Falls
Paterson
Rochelle Park
Tenafly
Rockaway
Boonton
New Bridge
Highwood
Englewood
Denville
Dover
Great Notch
Clifton
Hackensack
Bogota
Nordhoff
Parsipany
Cedar Grove
Lodi
Leonia
Mt. Tabor
Pine Brook
Franklin
Passaic
Garfield
Ridgefield Park
Troy
Verona
Montclair Hts.
Corona
Little Ferry
Ridgefield
Caldwell
Up. Montclair
Fairview
Carlstadt
Watchung
Morris Plains
Whippany
Montclair
Nutley
Rutherford
Fort Lee
Edgewater
Avondale
Lindhurst
Kingsland
Glen Ridge
Guttenburg
Bloomfield
Soho
New Durham
Secaucus
Morristown
Livingston
Llewellyn
Belleville
Arlington
Orange
Weehawken
Convent
East Orange
Harrison
West Hoboken
South Orange
Roseville
Madison
Hoboken
Chatham
Millburn
Irvington
NEWARK
Marion
Logansville
Summit
Hilton
JERSEY CITY
City Hall
Springfield
Basking Ridge
West Summit
Lyons Farm
Greenville
Lyons
Murray Hill
Salem
Waverly
Passaic R.
NEW YORK BAY
Gillette
Cranford
Roselle
Elizabethport
Bayonne
Stirling
Westfield
Scotch Plains
Picton
Elizabeth
New Brighton
Fanwood
Bergen Pt.
St. George
Tompkinsville
R. T.
Plainfield
Erastina
Port Richmond
Stapleton
Clifton
Leh. V.
Rahway
Concord
Marconnier
Ft. Wadsworth
Dunellen
Cen. R. R. of N. J.
STATEN ISLAND
Staten Island R. R.
Bound Brook
Carteret
South Plainfield
New Dorp
Menlo Park
Richmond
Gifford
Woodbridge
Metuchen
Perth Amboy
Annadale
Huguenot
Stelton
Prince's Bay
Bonhamtown
Tottenville
Millbush
Raritan R.
New Brunswick
South Amboy
Raritan Bay
Sayre V.
Sandy Hook
Sandy Hook Bay
South River
Morgan
Cliffwood
Port-Monmouth
Keyport
Matawan
Old Bridge
Monmouth Jc.
Hazlet
Atlantic Highlands
Middletown
Navesink Highlands
Spotswood
Dayton
Morganville
Fairview
Penn.
Seabright
Jamesburg
Wickatunk
Holmdel
N
Bradevelt
Red Bank
Hoffman's
Monmouth Beach
Cranbury
Englishtown
Shrewsbury
N. Long Branch
Tinton Falls
Long Branch
Eatontown
West End
NEW YORK
Electric Roads



RAILROAD MAP

OF

NEW YORK CITY

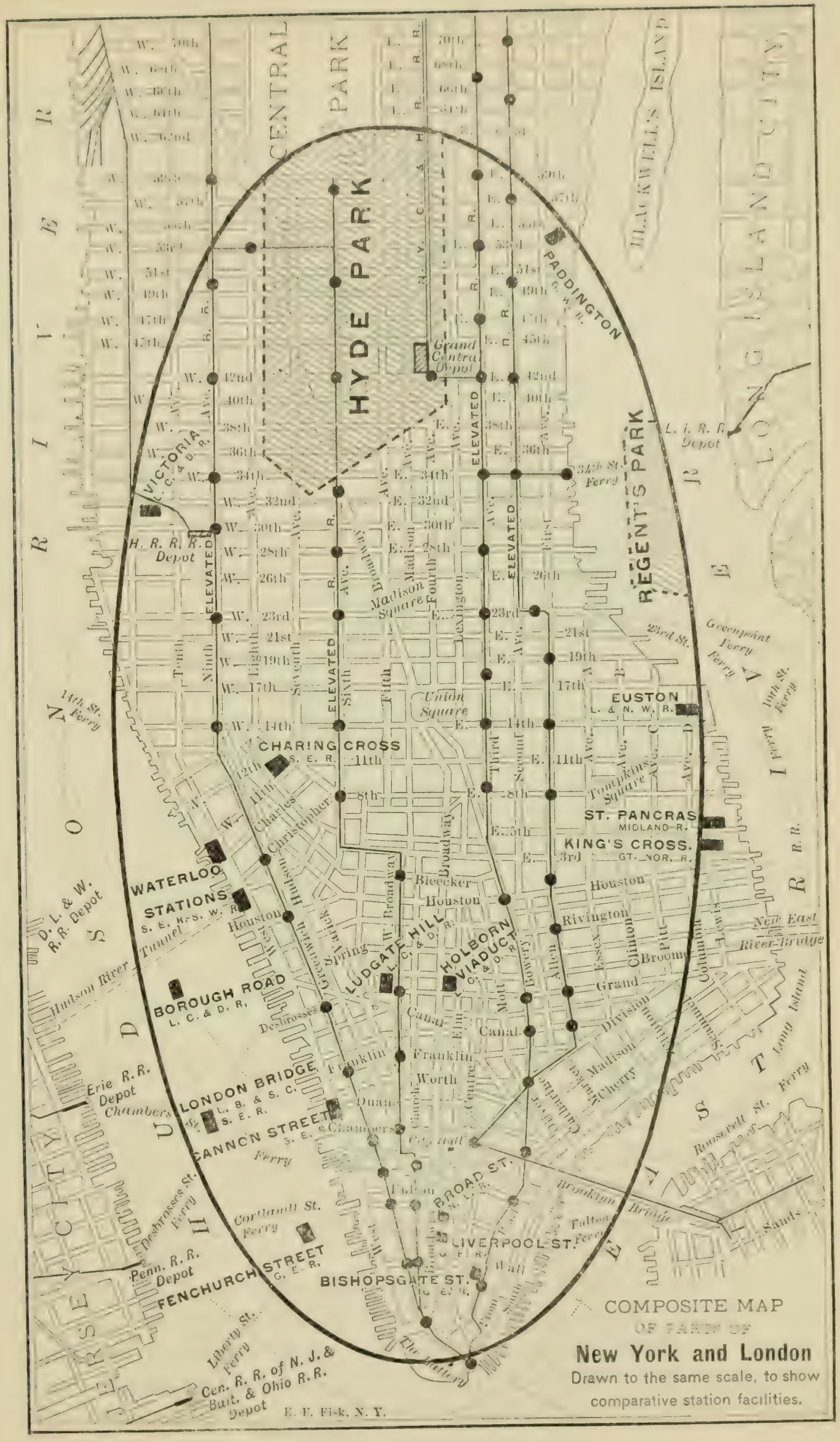
AND VICINITY.

major axis ; the inner circle, which is very far from a true circle by the way, skirts it so as to touch all except the Waterloo and London Bridge stations, which, being on the Surrey side, require special communication with the "city." For each of the other terminals there is a corresponding station of the underground railroad, either in direct connection or near by. There are also intermediate stations, and, as some main-line trains make use of the underground, these add to the number of the railroad facilities of suburban London. The route of the proposed Central London Electrical Railway, an underground way from the Bank of England to Shepherd's Bush at the extreme west of London, will extend along the major axis of the ellipse. The City and South London Railway, also underground, commences at the Monument and passes under the Thames to the southeastern suburbs. The South Eastern Railway Company is now engaged, at a cost of three million dollars, in constructing an underground electric line one and one-half miles long, mostly in tunnel, from Waterloo Station to the "city." The limits of this article do not permit us to go into the London system in detail, but we must not fail to remember the cheap and all-pervading cab, for which New York streets will, it is hoped, be suitably paved some day.

In order to see what New York would look like with a similar equipment of railroad stations, I have plotted the London terminals in their proper relative positions upon the New York map. It is interesting to note that Hyde park and Central park occupy analogous positions with reference to the "city" and to Wall street.

Our composite map shows that, with equal facilities to London's, New York would have seven terminal stations south of Chambers street and eleven more below Fifty-ninth street. Now let us imagine a continuous double-track railroad (with more than two tracks in places), with trains circulating in both directions and reaching all these terminals, and we shall have the London system. If we supplement it by still more tracks, by several cross-town tunnels, and one or more up- and down-town lines with stations at the intersections for distribution by shuttle-trains, we shall have in skeleton what, in my humble judgment, New York requires, and ultimately will have, for suburban facilities, some of the terminals being railroad stations and others ferries or other water routes. Finally, to complete our picture, we should add loops corresponding to the London "outer circle" and other circuits touching the inner circle but not always combining with it, because on any short-distance line train-capacity is relatively much greater than track-capacity.

It is a question worthy of deep consideration whether a system of separate terminals would in any given case be as satisfactory as a union



COMPOSITE MAP
OF PARTS OF
New York and London
Drawn to the same scale, to show
comparative station facilities.

terminal ; this requires to be studied from several points of view, but, so far as New York city is concerned, one union terminal would be inconveniently large and practically out of the question. Probably each of the suggested terminals would be a union of several lines, and doubtless would require all the space that could be secured in one enclosure. Rapid and convenient circulation between the separate terminals, and from those terminals to the business portions of the city, would be a *sine qua non*, whether it be a part of a so called rapid-transit system, or an entirely distinct distributing system, such as I have outlined above. If the latter should be adopted, it should embrace as much down-town territory as possible ; it should not occupy a central position, because that would involve the greatest degree of congestion with the least extent of accommodation. This is on a theory totally opposed to that upon which the rapid transit commissioners have located their line under Broadway. Below Fourteenth street a system affording the "greatest good to the greatest number," and furnishing the needed relief from the congested condition largely due to the absence of quick communication anywhere except in the immediate vicinity of Broadway, should run not far from the river fronts and be continuous. A natural and probable adjunct to such a system, underground or elevated, would be concentric outer tracks for suburban trains running directly in from junctions with their own lines, passing around the circulation and out again, and stopping at stations common to both the inner and outer tracks. In some places cross-lines would form cut-offs or short-circuits, and there would be transfer stations at intersections with other rapid-transit systems, if such should come to be provided.

Of course, we cannot have railroads coming into New York *ad libitum*, on account of the rivers : but at no distant day a number of them will probably find they can no longer afford to stay out. In fact, this discovery appears to have been made already, but there is great difficulty in getting in. It is conceded now by some good authorities that the abandonment of the former station of the Hudson River Railroad at Chambers street, and the down town stations of the Harlem and the New Haven lines, was a mistake. The same error of judgment was made in Philadelphia when the Pennsylvania Railroad removed its terminus to West Philadelphia, to be corrected a few years later at an enormous expense by its re-entry to Broad street. It is idle to theorize in regard to what might have happened had the old New York stations been retained and the railroad service fully developed in connection with them. For many years New York has been aware of its deficiencies, for which the authorities have suggested but one remedy,—rapid transit to the northern part of the city. Private parties have been busy with other plans—some extremely good and others entirely impracticable—for crossing the rivers, either under or above. The schemes that have been proposed for tunnelling under the North and East rivers are too numerous to specify here. Out of them all there is at least one very excellent project for a deep tunnel from Brooklyn to Jersey City with intermediate stations in New York. It is proposed to operate it independently, with electricity. It would be about two hundred feet below the surface, and would be reached by elevators. Nothing need be said here in regard to tunnels for bringing the present steam railroads under the rivers to an underground terminal ; such schemes make interesting reading, but will not bear the test of expert investigation.

The bridge that was begun a year or so ago across the East river at Blackwell's Island is for the purpose of extending the Long Island system to a terminal station between Second and Third avenues, not far from Sixty-fourth street. Two distinct projects for bridging the North river have in view terminals to be used by the New Jersey railroads. Without hazarding conjectures as to the time of completion of any of these bridges, we may assume that at some future day they will be accomplished facts. When they are, New York will have some suburban facilities worthy of the name ; there would then be a fair beginning of a separate terminal system, with four stations situated within a circle two miles in diameter, the center falling within the Grand Central Station. Lying just outside of this circle is the old Thirtieth Street station of the Hudson River Railroad, which, in all probability, will soon come into more important use for suburban passenger traffic than at present. Supplemented by outlying stations beyond the Harlem, the above group would have a vast aggregate capacity, and would provide for railroad communication to all the suburbs, including Staten Island, excepting those lying to the southeast, which probably will be better served by means of bridges to Brooklyn and the Brooklyn elevated railroads, assuming the trains of the latter to be run directly over to New York. The "new East River bridge" at Delancy street, which is about to be begun, will have, it is understood, two tracks for elevated railroads and four for trolleys.

So far we have been dealing with the most important end of this subject, for, with suitable provisions within the city for reaching the suburbs, the accommodations in the latter can easily keep pace with them. But it will be interesting to glance briefly at the suburban end also, and observe the new possibilities of development on the steam roads by means of electricity. In the references to steam roads I do not mean to imply that the suburban traffic upon them necessarily will continue to be moved directly by steam ; I retain the common designation to avoid any confusion with electric lines pure and simple; but it now appears very probable that there may be a general substitution of electricity upon the steam railroads as applied to suburban traffic, for which service it is peculiarly adapted. The present railroad facilities in the suburbs themselves are so diversified that it is difficult to speak generally and justly in regard to them. There has been a visible improvement within the past few years. There is still much to be desired, but very much depends upon the road. My Plainfield friends who go out in the "club car" probably would not agree that they are at all neglected, but any resident on Long Island would doubtless accept the proposition without question.

Some of the steam roads are not alone neglectful, but also singularly lacking in perception; they make no apparent effort to attract suburban travel, but deliberately act in a manner to discourage it, or even to drive it away to other lines. One railroad's stupidity in this respect is monumental; its management appears to have erroneously supposed that, because they, as a matter of fact, absolutely controlled the carrying trade of their territory, they therefore had no competition, and could do as they liked in maintaining excessive fares, furnishing poor accommodations, and even imposing gratuitous and unnecessary annoyances upon the public, without fear of losing their patrons. They seemed quite unaware of the existing powerful competition exercised by railroads leading in other directions or of the possibilities of their field being invaded by the ubiquitous trolley. They have, doubtless, ere this, sincerely regretted their mistake, and are paying very dearly just now for their lesson, which, it is to be hoped, they will profit by. The problem of supplying general communication to the suburbs is at present involved in considerable difficulty, due to the natural tendency of the trolley companies to parallel the steam roads and take the latter's business. This, while it has the effect of reducing fares, reacts on the community by forcing the steam roads to curtail their train service. In such cases the net result is not satisfactory to the public.

To escape from the ruinous competition, the steam roads will be obliged to occupy the field of the trolley themselves, either by owning the surface lines or by introducing electricity on their own lines. Both of these methods have been resorted to recently in the case of the New York, New Haven & Hartford Railroad, and it is extremely probable that the next few years will witness considerable modification in the trolley line development. On account of the limitation of speed that must be observed on streets and public highways, there is a corresponding limiting radius of operation for such lines. For short distances the lost time to the average traveler by the trolley does not weigh in the balance against lower fare; but with each additional mile the disadvantage becomes greater, and a point is reached beyond which it does not pay to use the trolley in preference to the steam road. In cases where trolley lines are built on independent right-of-way, and where the speed restriction does not exist, the competition is mitigated usually by the fact that the fixed charges for the electric road will be as great as, or even greater than, those of the steam road for the same distance.

Recent successful adaptations of electricity on steam railroads remove whatever doubts have heretofore existed as to the feasibility of electrically operating full-powered railroad systems. Most prominent and successful and convincing among these is what is known as the Nantasket Beach experiment, made during the past summer on the New York, New Haven & Hartford Railroad, which consisted of relaying twelve miles of double-track line in regular service to accommodate an electrical equipment while improving it for the steam locomotive service. Scarcely less demonstrative, though in a different way, is the highly successful performance of the 95-ton electric locomotive which is in constant service in Baltimore to haul entire trains, including the steam locomotive, through a tunnel. A high electrical authority has recently come out with a striking suggestion for the adoption of electricity generated by gas-engines for main-line operation of the Pennsylvania Railroad, claiming that only one-eighth of the present coal consumption "would be required, effecting a saving of four million tons of coal per year, now costing the railroad company above five million dollars,—a saving which would justify a large enough capital expenditure to cover the complete equipment of the railroad."

Ample experience has demonstrated that electric roads can be successfully operated with gradients and curvature far in excess of what would be feasible on a steam road, and for the purpose of suburban development the former are most admirably suited. There are numerous attractive and delightful locations close at hand, which have been heretofore practically inaccessible to the steam roads, but which can be reached by electric laterals in connection with them. With the multiplication of safe, speedy, and comfortable means of reaching the suburbs, the most powerful reason for overcrowding the city—necessity—will largely disappear; better opportunities for living and for enjoyment both to the suburbanite and the city man will be afforded. The future railroad facilities of suburban New York is a subject of vast importance to all her people, and calls for, and will undoubtedly repay, far more serious attention on the part of the steam railroad companies than it has received.

STANDPIPES FOR FIRE PROTECTION AND STREET FLUSHING.

By Louis L. Tribus.

WITHIN the recollection of the present generation the needs of large cities in the matter of water-supply for fire protection and sanitary requirements have undergone so complete a change that methods fully adequate twenty years ago are as little suited to the present as the early locomotives would be for hauling the modern fast express train.

The development from the bucket brigades, through the hand-pumping engines down to the present superb steam fire engines and trained fire departments, is an interesting one; but it is perhaps a question whether we have not reached a period where even better facilities for fire protection are a necessity.

Most large cities have been, or are being, provided with water-supplies adequate for all domestic and manufacturing purposes, under either gravity or pump pressures sufficient to raise the water to the top of buildings seven or eight stories in height; such buildings are well within the reach of fire streams from a good fire engine, also, so that all necessary conditions are satisfied.

But buildings are fast reaching an average of ten to twelve stories, many having nearly twice that number; and, while we do not forget that fire-proof construction improves as the roofs travel skyward, the fact is daily becoming more apparent that these tall buildings are beyond the reach of due protection from the public fire departments.

To attain necessary protection there must be a full water plant in each building,—piping, hydrants, hose, tanks, pumps, and boiler, and not infrequently artesian wells to furnish a supply of water independent of the public service.

In the aggregate these plants involve an immense investment of capital; yet such expenditure is warranted by the saving in insurance premiums under "full protection" clauses.

Fortunately, these tall buildings have so seldom been subjected to the test of fire that the complete inadequacy of present fire methods has not been proven; still, we know that at large fires, in even moderate-sized structures, it is necessary to couple two or more engines on the same line of hose or "water tower," in order to deliver sufficient water at a height where it can be effective.

What, then, could be done on the "sky scrapers," or even in the buildings of fourteen or fifteen stories, if their own protective agencies should break down? Nothing but wait until the fire should burn to a point within reach of the fire department, before which time the building probably would collapse through distortion of its iron frame by the heat.

Few large cities have a high-pressure water service. In the past this has been lacking largely because a low-pressure system met all requirements of domestic supply,—fire service and boiler use, other uses not having become fully apparent; in the present it is lacking because of the expense attending new installations.

Conditions are now changing; as already indicated, buildings are rearing their heads above the flow-line of reservoirs, and outreaching the capacity of established pumps. Business men recognize the economy of centralized power stations and distribution of energy to meet the actual daily and hourly needs of small powers. Communities are beginning to appreciate the value of fine street pavements, and the better sanitary condition and moral effect consequent on keeping them at a maximum of cleanliness.

To meet these changes, mechanical ingenuity has so far improved what may be called "municipal" machinery that work costs now only half as much as it did a few years ago. Pumping engines of high class, occupying small space, work with almost human intelligence under heavy strain, and show less tendency than their human prototype to break down under such tension. Again, decreased cost of iron and improvements in manufacture have contributed in making serviceable cast-iron pipe for high pressures, thus rendering feasible the construction of large plants at relatively small cost.

The use of steel frames in building construction permits the support of heavy weights at high elevations without devoting so much valuable ground space to masonry supporting walls as would have been necessary a few years ago. Now the masonry walls are needed only for ornament and protection of the interiors from the elements.

This very possibility carries with it the necessity for improved fire-proof construction, high-speed elevators instead of stairs, high-pressure water service, and forced heating and ventilation effected by steam, electric, water, or pneumatic power. To meet these requirements, various methods have been adopted. For electric service the reliance is mainly on central stations; for steam, on isolated plants, except in one noteworthy instance,—New York; for water, on isolated outfits, except in the case of one large system in London; for pneumatic power, almost entirely on individual plants.

It is universally conceded that, wherever feasible, there is advantage in storing water close to, and at sufficient elevation to flow by gravity to, the district that is to use it, thus discounting in a measure accidents to conduits or pumps. All will probably concede, also, that, in case of fire, the system which at the shortest notice will deliver full streams of water at the highest pressure is the best, the first few minutes often determining the result of a conflagration.

The tendency of growth in most cities is to occupy first the lowlands, spreading to the hills only when driven by necessity.

Many of our largest cities are at a considerable distance from any really high ground; most are near some large river or sea. What follows therefore? One of three things: either a water service by gravity from a distant source, usually producing rather low pressures; a pumping system delivering directly into the mains; or a combination of the two,—pumping from the point of delivery of the gravity supply into the mains direct, or to small reservoirs or tanks, of various capacities, raised to sufficient elevation for the water to flow by gravity to consumers. Of course there are many variations and combinations, but these cover the general conditions of public water service.

The point of special interest in this connection is for cities of the first class. That which will save hundreds of thousands of dollars annually will warrant an expenditure of great sums for installation of the saving plant.

One would have to draw largely on the imagination to estimate the saving in a city like New York or Chicago, could steam fire engines be abolished and hose companies substituted, could individual private pumping stations in private buildings be dispensed with, and could the hundreds of buildings paying high insurance rates be so protected as to place them in the class of "good risks," with consequent reduction of annual premiums.

In many cases such calls on the imagination might produce too severe a strain, yet in this one the results outlined for attainment seem feasible.

Let us suppose, first (not outside the pale of possibility), that the *quantity* of water supplied is fully sufficient for all needs, but that the *pressure* is inadequate for direct fire protection,—a very frequent case. One solution would be to establish at scattered points in the city separate pumping stations, drawing water from the larger supply mains and delivering it under high pressure into large tanks at high elevations, whence it would flow by gravity through the distribution pipes to all classes of consumers in the district. These districts should be separate, yet connected, so that at short notice, in an emergency, one could supply another also.

The districts should be so arranged that pressures throughout could be practically uniform, and compact, so that no long distribution lines would be needed.

Under such a service, every hydrant, all the time, would be, in effect, filling the place occupied by a steam fire engine, a few minutes after the rising of an emergency requiring its use.

By placing at each tall building a rising pipe,—inside or outside, as might be preferred,—with nozzle connections at each floor and hose attached ready for instant service, and with hose connections at the ground level, it would be possible in a very few moments to connect with the nearest street hydrant and have water flowing at any floor required without the trouble and delay incident to stretching long lines of hose and hauling it to the upper floors of buildings.

Better yet would be to have the street mains connected direct to these rising pipes, so as to be free of even the first delay in arrival of a hose company. These details, however, need not be discussed here; the subject is too wide to permit of more than suggestion at this time. This is no new principle or theory, but one which has for years been in use in isolated cases, though it has seldom entirely superseded the steam fire engines.

These stand pipes have been built in three main classes: a large wrought-iron or even wooden tank raised on a trestle; the same tank supported upon and enclosed by substantial masonry walls, and made an architecturally attractive structure; an immense wrought-iron or steel cylinder, filled with water from the ground up, in stable equilibrium because of its own weight and diameter.

For a large city these tanks might be of large diameter and occupy the top stories of high office-buildings or warehouses, rentals therefrom bringing a partial or even full return on the capital invested,—the basements being utilized for pumping stations. Here could be installed high-grade, economically-working pumping engines, capable of supplying, not only their own district, but an adjoining one as well, and keeping their own tank continually filled with water, drawing it from the main supply pipes or feeders, the water being delivered thereto either by gravity or by low service engines.

It needs but to call attention to the subject to establish the far greater relative efficiency of such a pumping plant, working under every mechanical advantage, over the peripatetic steam fire engine, whose one aim is to pump water in a hurry, when wanted, regardless of economy.

The benefits from the latter obtain only when in action in the emergency of a fire, while the former would be giving a continual service, and be ready more promptly in the emergency.

A few years since, another use for water under high pressure would have made a strong argument in favor of such establishment,—*viz.*, the demand for small powers for elevators, ventilating fans, and other light machinery for intermittent service, with the revenue obtainable from such use. But the transmission of electric power has become so universal and convenient that the need for water power is rapidly passing, electricity eliminating, as it does, the necessity of special piping, fixed shafts, and large waste pipes.

Another phase of municipal life now assuming important proportions is the cleaning of streets; the removal not simply of heavy refuse, but of the finely-divided particles of dust, which sweeping machines serve merely to again start in motion, carrying irritation and mayhap disease wherever it lodges. Sprinkling serves but to aggravate, or at best ameliorate, not to cure the condition.

A few cities provided with ample sewer accommodations are alive to the subject, and make use of water in quantity to capture and carry with it these finer matters, allowing the sewers and their flow to do the duty imperfectly done by sweeping machines and cleaning departments. Many notice and rejoice at the beautiful cleanliness of paved streets after a heavy rainstorm; the dirtiness at other times must necessarily be great to show so marked a contrast. Take that same pavement, turn a powerful stream of water upon it from a fire hose, and but a few minutes will be neeeded to thoroughly wash free and drive before it all the accumulated dust and dirt. Having substantial movable wire screens at the sewer basins, all coarse matters can be collected and removed in a cart.

This cleaning could not be thoroughly done with water under low pressure, except at great expense of time and water; but, with the suggested system, a cleaning gang, with a length of hose mounted on a number of pairs of low wheels, some six inches in diameter, operated by two men, and drawn by a horse, accompanied by a couple of other men to handle the screens, and a cart for the coarse *débris*, could in a few minutes clean a block thoroughly,—walks as well as streets. Attaching the hose successively to the fire hydrants, they could soon cover a very large district.

Night is the proper time for such service, though Paris does some of the lighter cleaning throughout the day as well.

Of course there are times when this method might not be entirely satisfactory; in intensely cold weather, for instance, the ice coatings likely to form might be too great a danger to life and limb, more than offsetting the cleanliness attained. But in the main it seems feasible, and an improvement on what may be called the "dry carriage" system by carts or machines only.

It must be borne in mind that pumping all this water under high pressure will cost large sums of money; the installation of a number of separate water systems dependent on great supply mains will take large capital; but would it not be fully warranted by adequate fire protection furnished, with the consequent reduction in insurance premiums, and by a thorough cleaning of streets, with the consequent lower rate of mortality.

Thus far it has been assumed that the supply of water was not only serviceable in purity, but practically unlimited in quantity, delivered without great expense for filtration or other means of purification. The reverse is not at all unlikely. In such cases, while the fire supply might properly be drawn from the purer waters, that for street flushing could not be economically so taken. Therefore it would be better to subdivide the service, delivering pure water at low pressure for domestic and boiler use, and establishing separate systems of mains for the high-pressure service for fire protection and street flushing, using untreated river water, or even salt water, if the city be near the sea.

The use of salt water, while more troublesome from its action on metal, is not at all impossible; coatings of preservative varnish will very fairly protect iron from its action, and working parts of pumps can be of bronze to resist corrosion.

There are some cases where it might be better to adopt the two systems,—low pressure for domestic use and high pressure for fire protection and street flushing,—from reasons of operative economy, in spite of the larger first cost of parallel pipe systems; but of that this article need not treat.

Some will no doubt say that these same results can be attained without using standpipes or towers at all, by pumping directly into the mains, and meeting fluctuation of consumption by regulating the speed of the pumps. This undoubtedly is practicable, but only at a sacrifice of efficiency, and does not provide the reserve of water held in the tank for sudden extra draught or a temporary break in the machinery,—points worthy of careful consideration.

Pressures considered here as relatively low and high are respectively below sixty pounds and from one hundred to one hundred and twenty-five pounds per square inch.

Undoubtedly there are objections to the standpipe system of water service in large cities, but a study of their conditions, daily becoming more serious, indicates the necessity of methods better adapted to serve the purposes of fire protection and street cleaning than any hitherto used on a large scale. The separate district high pressure service suggested herein seems to offer some of the advantages desired.

ARTISTIC ENGINE-ROOM INTERIORS.

By E. T. Adams.

AN engine-room where every decorative detail expresses an appropriate purpose of the designer has a just claim to be classed as artistic. Rooms of this type are a marked feature in late installations of power. This is especially noticeable in the smaller plants, where, largely because of the greater proportion of cost, the equipment and finish of the engine-room have usually been in most unfavorable contrast to those of rooms where the power developed is greater. This tendency in modern practice is not, as it may appear at first, wholly unimportant. It has been in response to just such demands that, in one short quarter-century, types differing as broadly as the Corliss and the single-valve automatic engines have been evolved from the single crude form which was then, practically, the one form available for any and all classes of service.

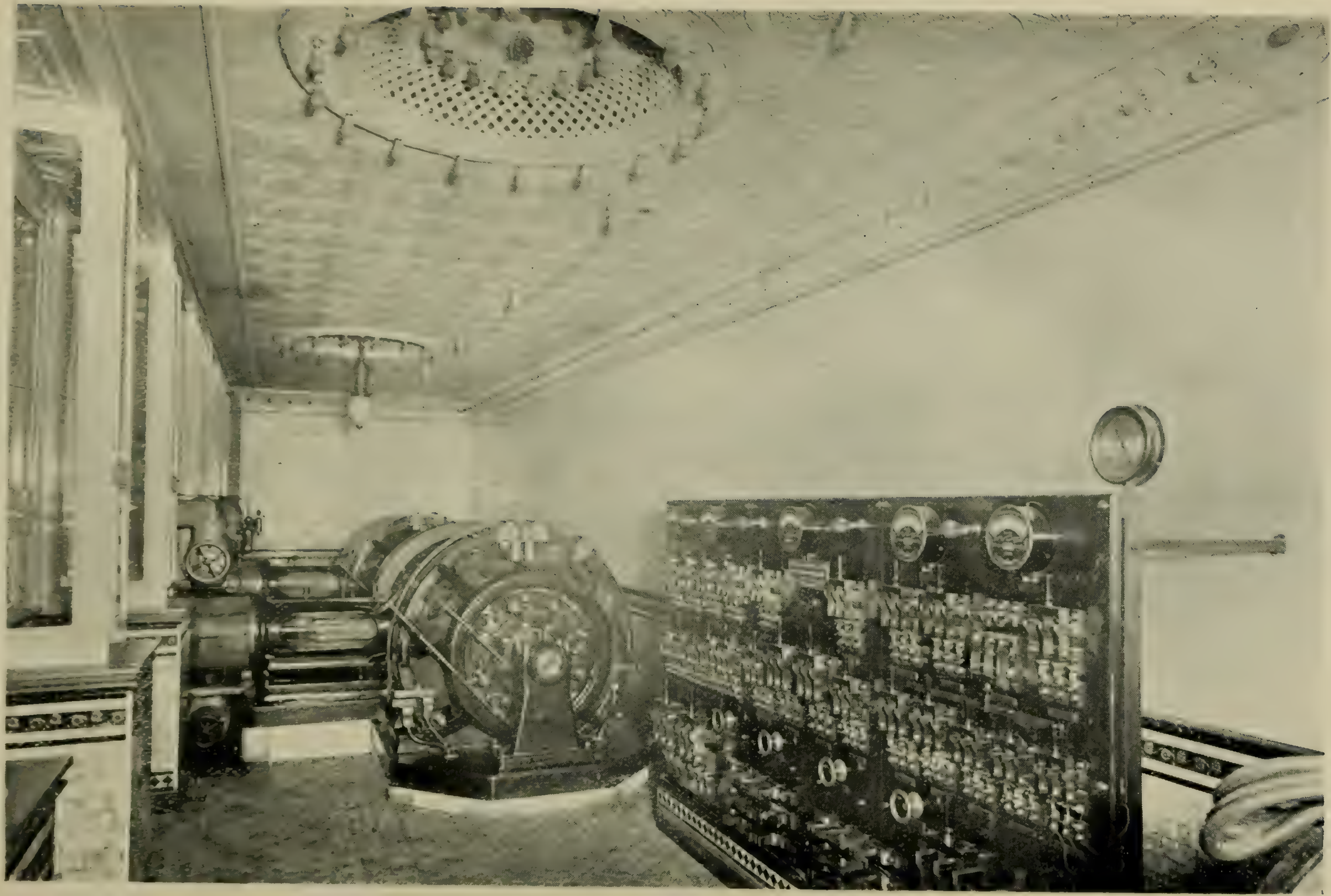
A more carefully considered engine-room involves some changes in engine design, mainly in the line of greater security against flying oil; but a matter of greater importance is the probable effect on the status of the stationary engineer. So long as the plant was located in some dark, uninviting corner, the engine could pound itself to pieces, or the boiler corrode to the exploding point, and, until disaster came, no one was the wiser. But with the modern type of engine room, easily accessible, neatly, often elegantly, fitted up, always brightly illuminated and scrupulously clean, the conditions are very different. The engine must run smoothly and noiselessly, there must be no jar or vibration, no smirch from flying oil or hiss of steam escaping past defective packing. These are simple requirements, but, to insure their fulfillment day after day, year in and year out, not only must the machinery be of the best, but the engineer in charge must be one who has received a thorough training,—a man of experience and judgment whose heart is in his work,—a man, in short, very different from the so-called engineer common under the old régime.

It certainly has been the common practice for owners of plants of moderate size to assume that the man who would consent to work the longest hours for the least wages was the cheapest man to employ, and this regardless of the advice and warning of engineers and engine builders or the record of disasters and deaths due to incompetence. If awakened pride shall now lead to a better practice, where legislative enactment and the dictates of business prudence have failed utterly, it will be an interesting, if not a unique, commentary on the working of the mind.

There is much to encourage the hope that the tendency of to day may become the settled practice of to-morrow; in effecting this the most potent element will be the pride that an owner takes in the proper appearance and operation of a plant which he has made attractive and which is open to inspection at any hour of the day. It takes years to demonstrate that the skilled engineer is the cheapest man to employ, but a very short trial suffices to show that the less skilled man cannot maintain, in the machinery under his care, the desired regularity and smoothness of action. Looking at the matter from the purely financial standpoint, the records of any engine builder will show that probably eighty per cent. of all repair work is made necessary, not by natural wear, but chiefly by neglect due to the shiftlessness and incompetence of the man in charge of the plant. In other words, an engineer of ordinary skill can, by exercising reasonable care, prevent four out of every five "breakdowns,"—an estimate which is, probably, considerably lower than it should be. It is very hard to give this degree of immunity from delay a cash value, but in many cases, even in small plants, it is a considerable item. Similarly, by careful usage, the useful life of an engine is very greatly increased and the cost of oil and supplies is proportionately reduced.

We overlook an important force in human progress, if we take no heed of the universal pride of man in that which he has creditably accomplished. The pride of the owner in the plant that has been artistically planned and carefully executed is matched by the pride of the engineer in maintaining the brightness and efficiency of the machinery under his care, and the consequences to each are of no mean importance. The intelligent interest of the employer in the plant that he has created will tend toward efficiency and economy in its management, and, in time, result in an appreciation of the duties and qualities of those on whom the actual work of operation devolves. On the employee these conditions enforce a healthy bodily activity and the habit of doing things promptly and efficiently.

For many years—it may be the practice still—the Southern Pacific Railroad Company offered prizes for the best-kept engine in each division,—an honor that was most keenly competed for. The engines certainly presented a magnificent appearance; the bright-work was always shining, the russia iron covering for the boiler clean and clear from spots, the cab tidy, the bell-rope carefully braided, even the running board carefully wiped,—in fact, every detail received thoughtful attention. But, much as the engine was admired, the impressive figure was the fireman, alert, active, out along the running board at each station, touching up a bolthead or band, in his neat cap, polished shoes, and spotless overalls, the figure of manliness. If the system had no



ENGINE-ROOM, HILTON, HUGHES & CO., NEW YORK.

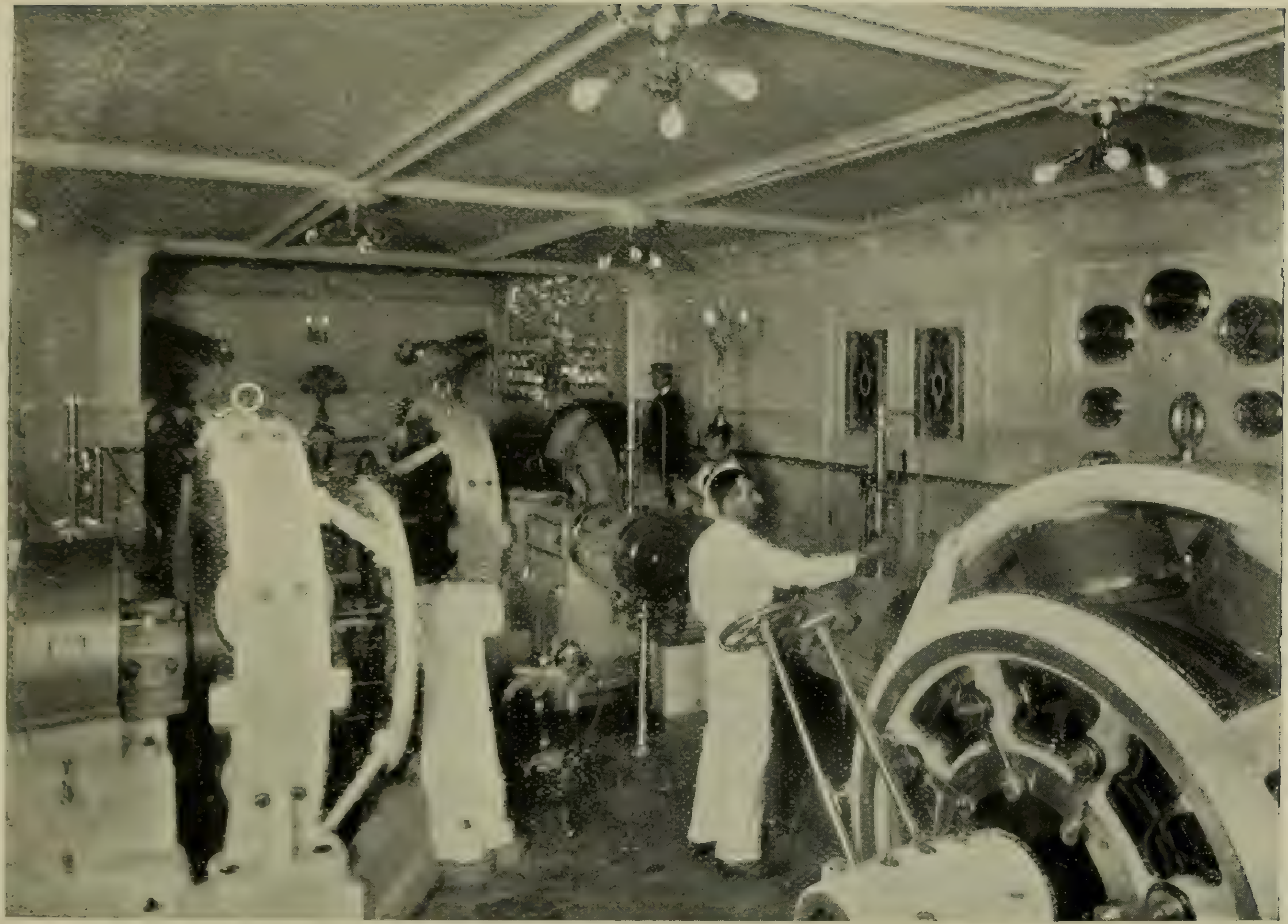
other result than the training it gave the men, it was well worthy of perpetuation.

What is appropriate in the design and finish of the engine room depends on circumstances. The Hilton-Hughes plant, for example, is on one of the main floors of a beautiful store, and manifestly should be in keeping with its surroundings. The plant at Keith's, again, is one of the artistic features of a most attractive theatre. From plants like these, where the expense for decoration alone runs far up into the thousands of dollars, to the modest room with whitewashed walls and a smooth substantial floor, there are infinite gradations, each perfectly appropriate in its place, and all including the same essentials,—perfect cleanliness and an abundance of light, since each of these is essential for the proper care of the machinery, and substantial construction for those parts that must withstand severe usage.

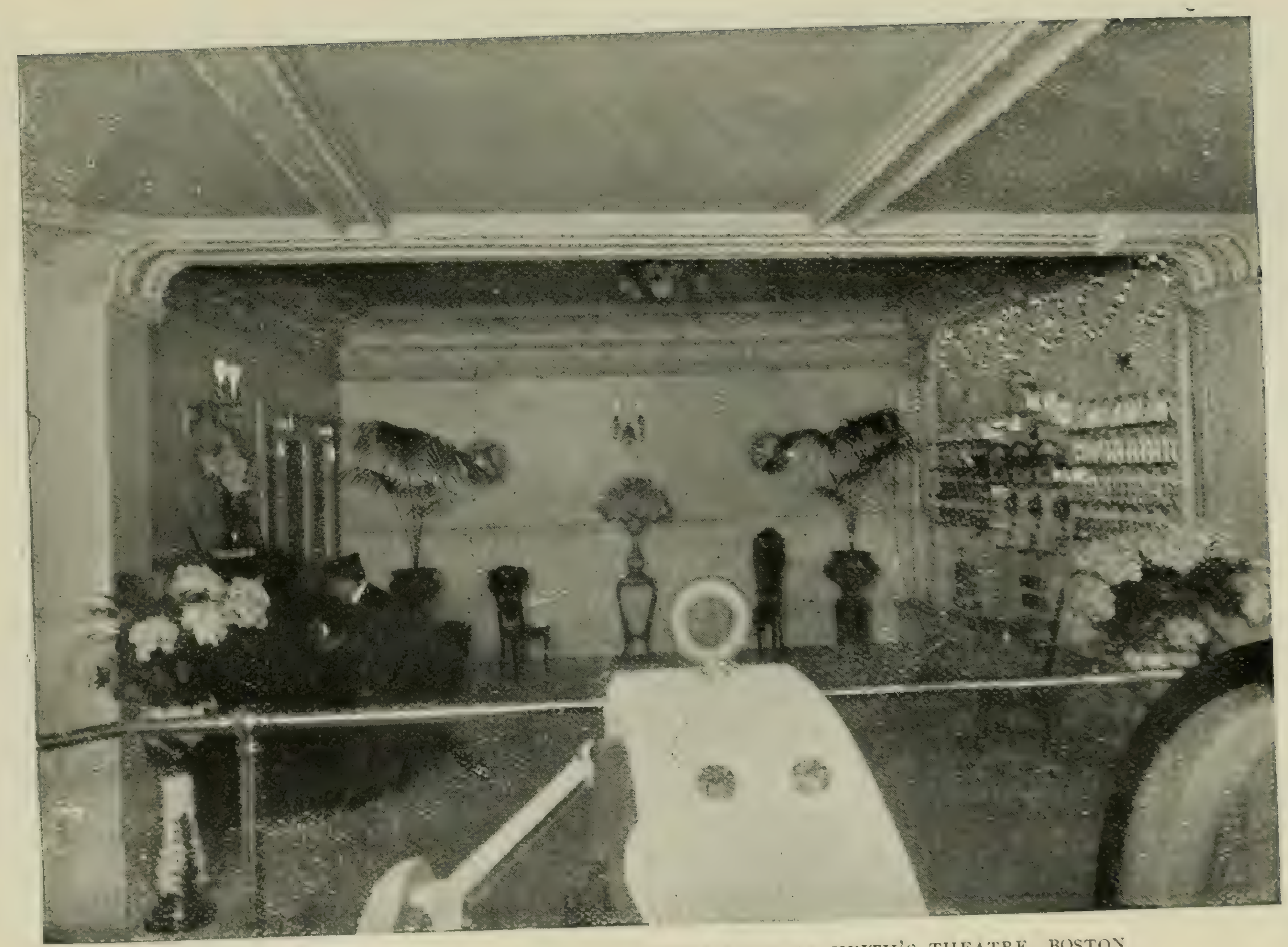
Of modern artistic engine-rooms one of the most beautiful is the plant at Keith's Theatre in Boston, of which general views are here presented. This plant furnishes light for the theatre, including that used for producing scenic effects. A beautifully-decorated and brilliantly-lighted tunnel connects with the main entrance to the theatre, and the place is visited and admired nightly by many to whom an engine-room of this class is a most attractive novelty. The entire room is finished in marble, as is clearly shown by the cuts ; unfortunately it is not possible to reproduce the beautiful coloring, or the effects obtained by the tasteful grouping of incandescent lights, to both of which the place is deeply indebted for its artistic effects. The engines are an enclosed type, the Harrisburg Ideal, and it is practically impossible for a drop of oil to be thrown from any part of the machinery,—a fact to which the spotless white of the uniforms of the engineers bears unimpeachable testimony.

There is nothing incongruous in marble wainscot, buhl tables, and potted palms in an engine room where, as here, it forms an integral part of a beautiful entrance, and is in itself an attraction of no mean importance in a place where attractiveness is all-important. The engineering features connected with the concealed piping and the arrangements for conveying oil to the engine room are of more than passing interest, but somewhat beyond the scope of the present article.

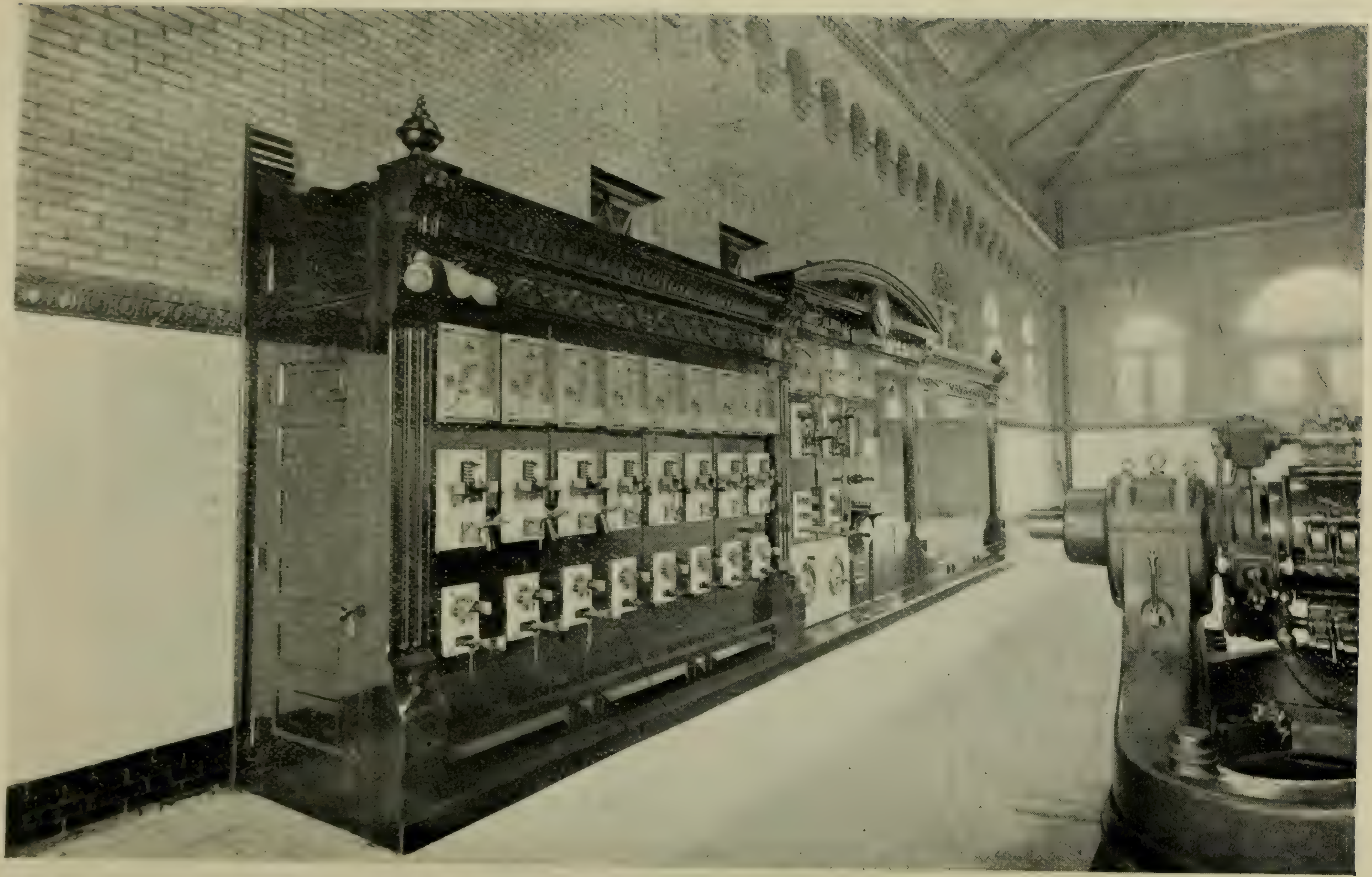
The cuts on pages 1052, and 1053 are from photographs of the power station of the Columbus Central Railroad, of Columbus, Ohio. This station, started with 800 h. p., is intended to, and soon will, accommodate about 2500 h. p. There is no cash value to an engine room as an attraction in this case. The power house is to furnish power for a purely commercial enterprise, and the delightful taste exhibited in fitting it up seems to be simply a way of expressing a love of



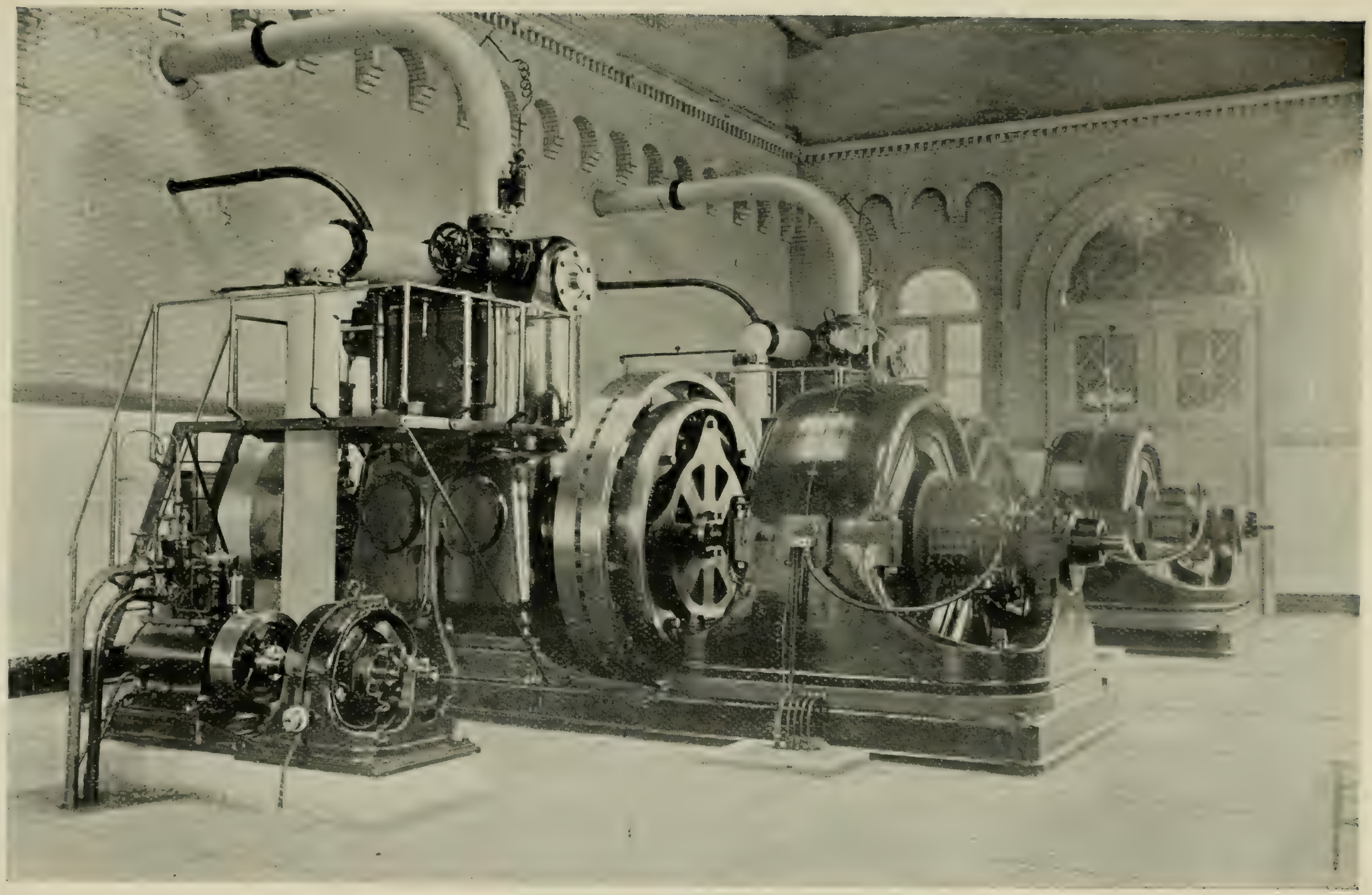
ENGINE-ROOM, KEITH'S THEATRE, BOSTON.



RECEPTION ROOM AND SWITCHBOARD IN ENGINE-ROOM OF KEITH'S THEATRE, BOSTON.



SWITCHBOARD IN THE ENGINE-ROOM OF COLUMBUS CENTRAL RAILROAD, COLUMBUS, O.

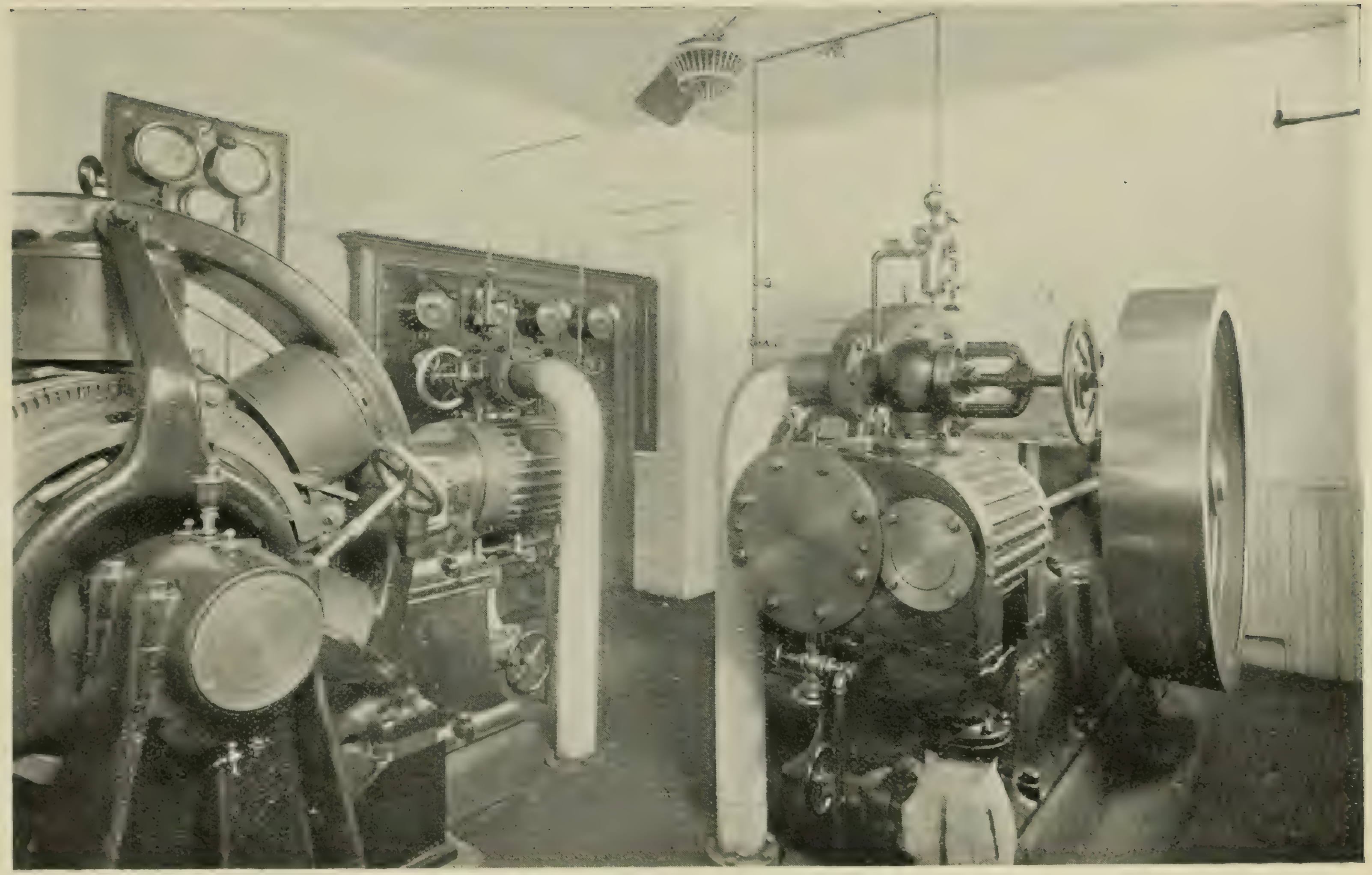


ENGINE-ROOM OF COLUMBUS, CENTRAL RAILROAD, COLUMBUS, O.

thorough, honest construction. To that which has been carefully planned and which will endure, we can certainly afford to give an appropriate finish. The building is of pressed brick and cut stone. Inside, up to seven feet in height, there is white enameled tile surmounted by a band of terra cotta ; above this the wall is buff pressed brick, and the frieze is outlined with arches and a line of incandescent lamps. The switchboard is of finely-polished mahogany, severely plain, save for some fine hand-carving, which it is impossible to adequately reproduce in cuts of the size here used. Everything is expressive of thoroughness, and it is no surprise to discover that the boiler-room is supplied with economizers and every appliance for getting the maximum number of heat units from the fuel consumed, or that the rails are heavy and the bonding most thorough. Again, we note the enclosed type of engine,—Westinghouse compound this time, but affording absolute security against flying oil. At the present time engines of the same type affording about one thousand additional horse power are being installed, room having been provided for them in the original plan.

In New York city a most beautiful thing of this kind is the plant at the establishment of Hilton, Hughes & Co. The engine-room, which is comparatively narrow, extends for upwards of sixty feet along one end of one of the main floors of the store, this side of the engine-room being fitted for its entire length with columns alternating with plate glass. As in the plant at Keith's, the floor of the engine room is dropped a little below the general floor line, and the glass permits the visitor to overlook the entire installation. The floor is of iron and cement, faced with mosaic tile ; the walls of white enamel tile with a dado of figured enamel tile and fringe of moulded tile, and studded with incandescent lamps with ground glass globes. The ceiling is of pressed steel especially designed, enameled white, and relieved by clusters of lamps, both arc and incandescent. The switchboard is of dark onyx, and is most artistically arranged. The engines are of a type not originally enclosed, but the safeguards adopted are effective, and there is no trouble from flying oil. These engines were built by the Payne Engine Co., and, as now built, are practically an enclosed type, although the original design has not by any means been wholly abandoned.

The engine room of the Hotel Stenton, Philadelphia, is one of the most artistic that I know of. In few plants of its size have the essential details been so carefully and thoroughly studied. Every part is accessible, the piping is concealed. There is good light and good ventilation, and more than all, they have shown rare good sense in not introducing decoration when there was no reason for doing so. The



ENGINE-ROOM, HOTEL STENTON, PHILADELPHIA.

usual practice would be to heat that little room to an unbearable temperature, by leading through it a mass of steam and exhaust piping; then the fair white wall would have been hastily tattooed with some stenciled ornament stolen from a Greek vase, and the result would have been called artistic! I claim that decoration is out of place in the engine-room, unless the *surroundings* demand it.

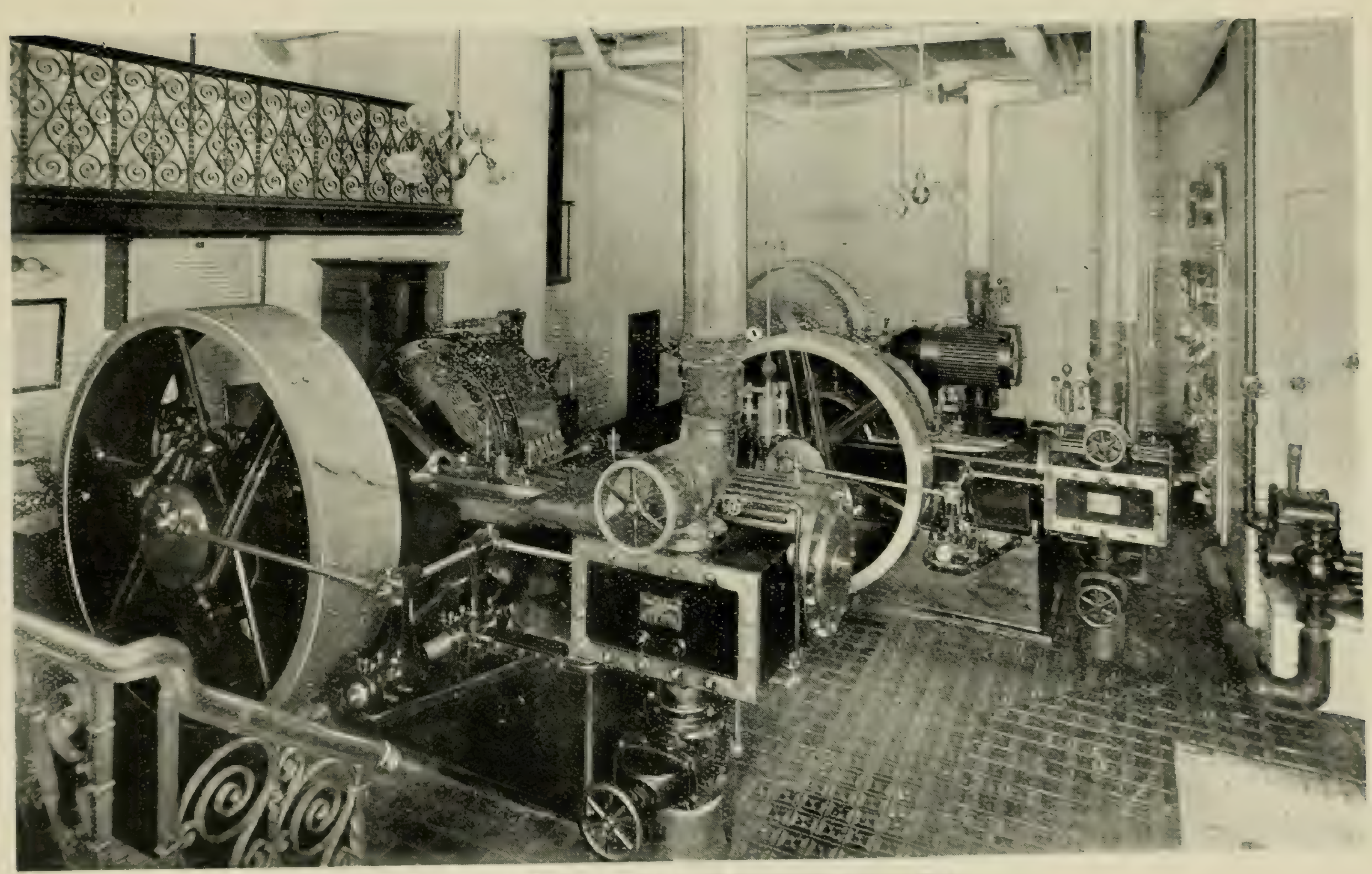
Another very handsome engine room is that of the Presbyterian Building, on the corner of Fifth avenue and Twentieth street, New York, which has lately been equipped by the Ball & Wood Company. The floor is handsomely tiled, while the walls are of white enameled brick; all the exposed piping is neatly covered with non-conducting material, and a handsome visitors' gallery occupies one side of the room, as shown in the illustration. All of the machinery is expensive and finely finished, the engines of course being carefully fitted with guards to prevent flying oil. The desire for thoroughly artistic treatment originated with the owners and architect, their theory being that the engineers could be relied upon to take much better care of the plant if every feature of the equipment were rendered sufficiently attractive to bring visitors to the gallery.

The sensitiveness of the engine trade is remarkable. Engine-rooms such as we have illustrated form but a small percentage even of those equipped during the past year; yet many drafting rooms have felt their influence, and at least two thoroughly established and well-known firms are now making radical changes to put them in line for this class of trade.

The logic of the situation seems to point to an enclosed type of engine; at any rate, if the engine is not absolutely enclosed, there must be effective protection from flying oil. Probably every engine now on the market has an oil shield affording some measure of protection, but practically all these devices have two vital defects: first, none of them affords absolute protection; second, few, if any, appear to be an integral part of the frame to which they are attached. It must be remarked, however, that no one has been so quick as the manufacturer to realize that the public is fast being educated to demand better things,—to demand symmetry for the whole and purpose in the form of each part.

As a secondary effect there seems likely to be a radical change in the system of oiling. A bath system of lubrication has long been recognized as the most perfect, and the majority of engine-builders have adhered to the old "drop by drop" method solely because the oil shields were not effective: they could not employ the method they knew to be best.

What is admissible in the amount of bright work about an engine



ENGINE-ROOM, PRESBYTERIAN BUILDING, NEW YORK.

is a more difficult point to determine ; certainly the barbaric display of nickel plate, common in the past few years, cannot long withstand the refining influence of artistic surroundings. Yet a certain amount of polished work is entirely in good taste. An engine requires care, and nothing more clearly indicates that care than the gleam of polished brass and steel. This is a refinement that will come, and on all sides are the indications that there will be delicate appreciation of it on the part of the public. The more liberal patronage of the arts ; the astonishing advances in architecture ; the demand for artistic furnishings,—all mark the rising tide of enlightenment of the mass of the people. In architecture artistic massing of light and shade and effective treatment of roof lines find wide appreciation, and homes in every hamlet mark the popular response to the influence of a true art, to which nothing is mean, nothing lowly. In engineering structures the advance in artistic treatment has been as remarkable, although not as obvious to the non-technical public. In this advance the designer of electrical machinery has taken a leading part ; with no traditions to impede the free exercise of his taste and judgment, he has had absolute freedom to follow the promptings of high ideals. The artistic treatment of electrical design was not without its influence in the field of steam engineering And thus it comes to pass that the electrical and mechanical engineer, the capitalist and the architect, have each a part in producing a harmonious whole, which cannot fail to exert a refining influence on all connected with it. The artistic engine-room is a link in a chain of influences tending to produce a higher type of manhood.

LIGHTING RESIDENCES BY ELECTRICITY.

By Augustus Noll.

IN no class of buildings is gas for illuminating purposes being displaced more rapidly by electricity than in residences. The advantages of electricity over gas are very numerous, but for the purpose of this article only a few will be discussed. When we consider that not only is the sanitation and ventilation improved, but the furnishings and decorations are also preserved, and that electricity's cleanliness, the absence of flame, heat, etc., and the color of the rays permit the use of more delicate tints and costly fabrics, to say nothing of its safety and low cost if properly installed, we need not look further for the reason of its use by the social world; as a matter of fact, in a modern residence the decorations would sometimes be impossible if gas were used for illumination, and, for similar results, the system of lighting by electricity, as now installed, could not be replaced by gas or any other known method.

The lighting of a first-class residence requires different treatment from that required in office-buildings, hotels, etc.; in the latter the location and number of lamps are fixed and their uses are well understood, while in the former the lights cannot be located by general rules, but must be treated in accordance with the existing conditions.

If the residence is of the ordinary class, the usual chandeliers and side brackets are employed; but, if the residence is of a high grade, the lighting will probably be an important factor in the decoration, and, unless it receives proper treatment, it may mar the effect intended by the artist.

Except in the library and the dining-room, chandeliers are now seldom used; they are economical, but, however artistic they may be, they generally obstruct the view and are not to be tolerated.

Where decorations are of a high grade, it would be well for the electrical engineer, even if he has had some experience in lighting, to coöperate with the artist having the work in charge, deferring to his judgment as to the location and amount of light to be used, and confining himself more particularly to the mechanical portion of the electrical work, such as control of light, appliances, etc., submitting such data to the artist.

For a well lighted room, the general tendency is to hide the lamps, unless the bulbs are used as a part of the decorations, but to so distribute them that an even diffusion of light is obtained throughout the entire space, the effect sought being that of natural light. The diffusion should be even, care being taken that shadows are not cast by the furniture, etc.

The wiring should be arranged so that lamps of greater or less candle power can be used, enabling the effects of increase and decrease of light to be noted and compared. The lamps and sockets should be interchangeable, as sometimes it is preferable to use a greater number of lamps of small candle power, so that no one portion of the room will be more brilliant than another, and also to keep the general tone of the colors forming the decorations the same throughout. Too much light is sometimes worse than not quite enough, and, in addition to its painful effect on the eyes, it gives a defective idea of color, shape, dimension, etc.

For general illumination in the principal rooms, an allowance of sixteen c. p. to each thirty or forty square feet will be satisfactory ; for chambers, etc., an allowance of sixteen c. p. for every fifty square feet is usual, assuming that the height of ceilings is ordinary.

Hallway and staircase lighting depends mainly on the shape and obstructions. In general, it is better to increase the number of outlets, placing fewer lamps on each group, thereby securing a more even light, overcoming the shadows on the stairs, and obviating the danger of tripping or falling. Outlets should also be provided for stand lamps, piano and fairy lamps, and other ornamental and portable articles. These should be located in the baseboard or floor. Each mantle should be equipped with two outlets for candelabra, vases, etc. ; the library, hall, and dining room should also be provided with a number of these outlets for ornamental lighting, as they are very useful for decorating tables, lighting pictures, etc. Flexible cables can be carried from these outlets to foliage, etc., interspersing the same with numerous miniature lamps of different colors, producing the most beautiful effects.

Very often the mistress of the household desires a change in the position of the furniture, or wishes to embellish a favorite nook or corner ; or decorations are required for special occasions, such as receptions, balls, dinners, etc. Then these outlets will permit the indulgence of any fancy in decorative lighting, and without great expense or annoyance of workmen. It also prevents cutting of floors, wood-work, or plaster.

The principal idea should be to create and instal a system of lighting that embraces safety and permanence, together with elasticity and control,—a system in which all parts are more or less movable and accessible, the only fixed portion being the system of conduits.

Some of the most difficult problems encountered in residential lighting are the pictures and cathedral glass windows and colored domes. In the latter the general rule is to place the lamps at a distance, thus obviating all spotty appearance. A frame of wood corresponding with the frame of the dome or window can be constructed, on which to place the lamps; the number depends on the size, color, and thickness of the glass, but experience has shown that too much light is a good fault in cases of this kind, as far as the lighting effect of the dome or window is concerned. It is a very expensive decoration to maintain, on account of the immense amount of light required.

Small domes and windows can sometimes be lighted to good advantage by one reflector, provided there is sufficient space at the back. Another way would be to form a recess on the sides in the rear of the window, in which to place a reflector throwing the light across the back of the glass.

The lighting of pictures is not susceptible of treatment by any general rule, although ordinary pictures can be lighted by reflectors made especially for the purpose. The reflectors usually employed in public art galleries are altogether unsuited for residential purposes, on account of their appearance, as the art gallery in a residence generally serves also as a study or library. An effective way, if the room is not too wide, would be to locate reflectors on the ceiling about eight feet apart and midway between the side walls. They can be circular in shape and attractive in appearance. The form of the reflector is governed by the space to be lighted, and is determined by mathematical principles; to overcome the glare, the lamps are almost hidden from sight. By this method of lighting not only are the pictures satisfactorily lighted, but a fair diffusion of light is secured for general illumination of the room.

Regarding the lighting of high-grade oil paintings,—though this is generally undertaken only by specialists,—it may be of interest to explain some of the conditions which must be considered, if the lighting is to be technically correct. Usually satisfactory results are obtained only after numerous practical experiments. The amount of light needed and the form of the reflector depend upon the size, predominating color, and character of the picture, the shape and depth of the frame, and whether the picture is covered by glass.

The material and the form of the reflector must be carefully considered. Sometimes it is constructed of glass, plated with metallic silver, and, in other instances, the reflecting surface consists of soft white enamel; it is often necessary to arrange the angles of the reflector so that a strong light will be obtained. Again, if a softer light is necessary, the glass forming the reflector is made into small "facets," and fitted into the different shapes forming the various angles of the reflector.

In considering an electrical installation for a residence, the proper control of the system of lighting is very important. Switches must be provided controlling the ceiling lights in the various rooms, and should be located at or near the entrance. Where the lighting is extensive or a great number of lights are located on the same fixture, they should be subdivided into various circuits, each circuit being controlled by a switch ; while this slightly increases the first cost, the saving in light and the cost thereof more than offset this in a very short time.

In bed-chambers a switch should be located on the side wall and within easy reach of the bed, with an outlet directly above. This outlet and its control form a great accommodation in times of sickness and for reading. Switches are also located in the frames of doors in such manner that, when the door is opened, the light appears, vanishing when the door closes. Generally closets, store-rooms, etc., are fitted in this manner.

The cellar lighting is usually controlled by a switch located at the head of the cellar stairs ; the servants' stairway is generally fitted with a circuit controlling all the lights upon it, with a switch on each floor. The switches are so connected that any one of them controls the lights ; this is expensive, but the lights are operated only when actually required, while otherwise they would be in constant operation.

The pilot or night circuit should also be provided, keeping this circuit and system separate from the rest, arranging one light on each fixture throughout the hallways, and providing a switch at the main entrance, a switch on each floor, and a switch in the principal chamber. This circuit will be found a great accommodation in case of sickness or a visit from burglars, as well as for the belated "club man." The connections should be made so that the light can be operated from any switch. A connection can also be made from this circuit to the vestibule door and connected by switch in the frame of the door so that the opening of the door will flood the hall with light, the light being turned off from any of the remaining switches. Another connection can also be carried to the burglar alarm and arranged to operate in conjunction therewith. Thereby, the instant that the burglar alarm is thrown into operation, the halls are lighted.

The most satisfactory system of feeders for residential purposes is generally a feeder controlling all the lights on the main floors, exclusive of the pilot circuit and servants' quarters, and another controlling the pilot lighting and servants' quarters. These feeders should be carried to the cellar and connected with switches ; during the absence of the family the switch controlling the main system can be broken, making it absolutely certain that the wires are "dead." Another method is to extend the main line to the owner's chamber, locating the switch therein, and thereby bringing the entire system under his control at all times.

The wire forming the circuits should be the very best obtainable; and, to secure the best results and latitude in increasing the number of lights or its candle power, a wire somewhat larger than that actually required should be installed.

The various circuits should be brought to some central point, and there connected with cut-outs, providing a cut-out for each pole of each circuit, the cut-outs to be located in a cabinet, and the cabinet lined and covered with slate to make it fire-proof. A switch should be placed between the feeder and the top circuits, so that all the circuits serving the lights on the floor may be disconnected without interfering with the lighting system on the other floors. The switches and floor outlet boxes should be of the "flush" type, the cover matching its surroundings in color, and in material if possible. Every precaution should be taken to make the cover fire and moisture proof; and the connections should be easy of access.

The system of conduits is probably the most important element in the entire work of installation. It is really the only fixed portion, and, when once placed, is usually inaccessible without resorting to excessive cutting of wood-work or plaster. To secure satisfactory results iron-armored conduits should be used throughout, as on them depend the safety and permanence of the system. Defective circuits, switches, and cut-outs can be removed without any great expense and annoyance and in a short time. These conduits withstand the blow of a hammer, and will shed nails, etc. The interior diameter should be so large that the wires will not be unduly crowded. In a proper conduit system leading lines or fish wires should be unnecessary, and, if numerous elbows are required, fish boxes can be inserted on the line at intervals. Proper precautions should be taken at all joints so that gas and water will be excluded; and where outlets terminate, either for switch or fixture, the terminals should be provided with the boxes especially adapted for the system, and all ends of conduits should be entirely closed, using some insulating material for the purpose. The conduits should be located in some definite place,—for instance, under floors in the hallways,—and should be run at right angles as far as possible, so that, in the event of any future alterations, the various lines can easily be traced.

In leaving this subject, it may be in place to mention the various other accommodations afforded in residences by the use of electricity, such as the operation of the dumb-waiter and passenger elevator, the pumping of water, the heating of plates and of foot-warmers for invalids, imitation of open-grate fire in the hearth, the ventilation of rooms, and fans for the sick chamber.

THE ARCHITECTURE OF MODERN BANK BUILDINGS.

By R. W. Gibson.

I.

As old as civilization is commerce, and as old as commerce is banking. Its methods have undergone many modifications. Its science has been specialized in many directions. Its primitive aim—the utilization of money (or its equivalent) deposited for safe keeping—has been subdivided into numerous branches. The simple safe keeping of money is now only one department of a modern bank. Indeed, it may fairly be said that safe keeping never was banking,—that this science began only when the control and custody of funds were made productive by the utilization of the credit and power inherent in them. But this is no new science. The Romans and the Greeks, and even the Egyptians, knew the principles of interest, discount, and exchange, as methods of business already established for centuries.

The banking house and the subdivisions and furnishings of it are the machinery by which the banker carries into practice his theories and purposes. He is limited by them, just as his intellectual power is limited by his physical capacity. At the best the machinery is cumbersome. The inertia of an army of subordinates ; the hampering effects of precautions against fraud ; the resistance of mere time and space, which remove successive acts one from the other,—all these things impede the genius which inspires them. To reduce such obstacles is to succeed ; to minimize them is to achieve brilliant success. Modern equipment places at the disposal of an executive the best allowable means of carrying out his plans.

The main features sought in a modern American bank may be summed up thus : First, facility for transaction of business with customers ; involving the proper disposition of the floor spaces of a banking room for the reception of the public by the staff of the bank. Second, facility for the direction by officers, and the execution by subordinates, of the internal work ; including proper relationship of different departments to each other, the location of various rooms, cages, and departments for their coöperation, and the furnishing of all with the best facilities, in their desks, counters, screens, cases, and so on, and in the most recent time and labor-saving appliances, telephones, calls, lifts, and the like. Third, security; not only for the valuables in the custody of the bank, but also for the business confidences of which it is the recipient, and for its own records and documents, by the use of fire-proof, burglar-proof, and mob-proof appliances, vaults, safes, etc., and their accessories for police communication, and by the enduring and fire-resisting character of the whole building. Fourth, reputation and prestige; in the evidences of stability and wisdom as reflected in an artistic as well as dignified, handsome, and well-ordered building,—these things bearing upon architecture as a fine art. Fifth, comfort and convenience; including their humanitarian and economic value.

It would be idle to discuss the right to chief place in just appreciation of all these subjects; yet it cannot be doubted that their relative importance has not been altogether well weighed. Let us give a few moments to art, the least valued among them. Architecture has been too much ignored. Art, as the utterance of living sentiments, has been either banished or overwhelmed in sordid practicality. Architecture for banking has come to mean all of the aims just recited, except the fourth, which is the soul of the organization. Its inclusion here, and its basis upon sentiment, call for the first explanation, and this alone is an admission of an apologetic attitude. Yet, next after the institutions of religion and those of the State, there are none more naturally associated with monumental architecture than the corporations of finance, none which have more to offer to and to receive from architecture, the fine art, the sentiment, the silent language. All these organizations, although founded on realities, are alike sustained by sentiment. Their continued existence depends on public confidence and faith, in things which cannot be always in evidence to the senses; and this confidence is an untamed thing, with nerves sensitive to unrealities as well as to facts,—in short, susceptible to sentiment.

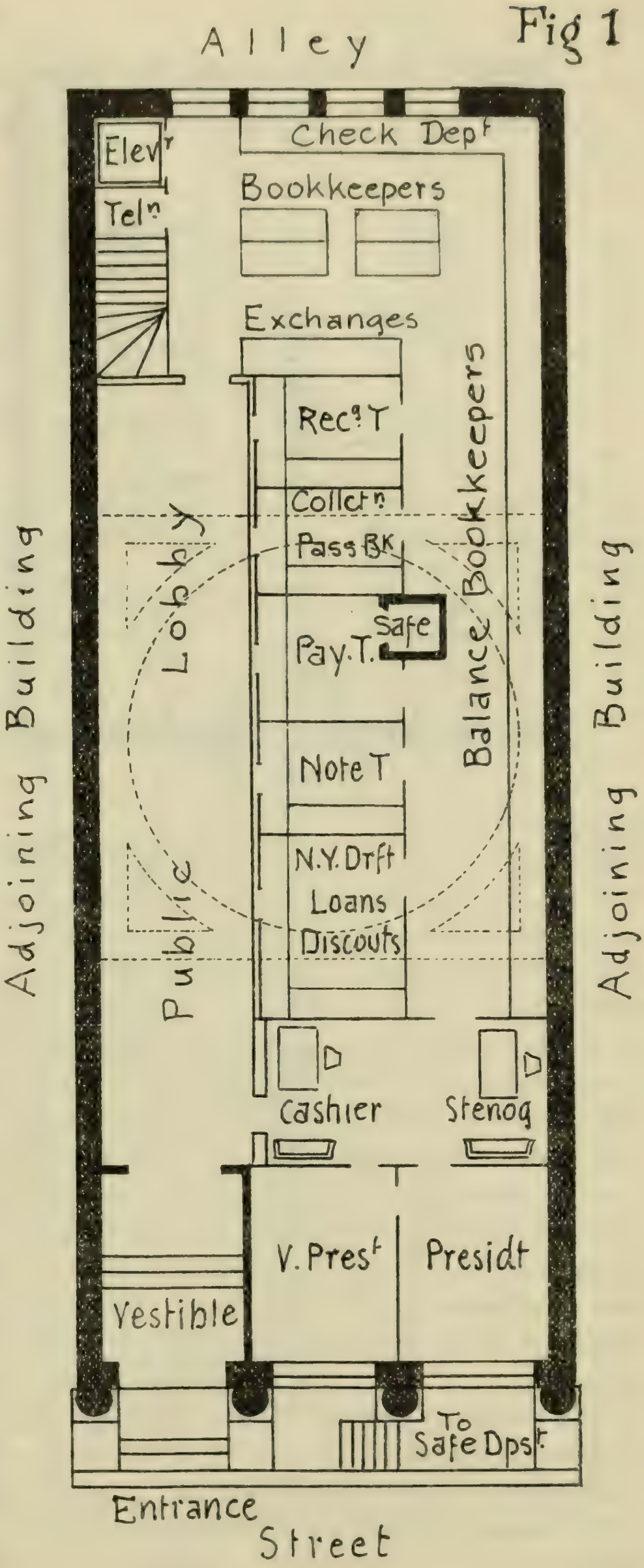
The churches have always recognized these arguments. What church has become great without temples, or what temples have been prized which did not place sentimental art as high as utility? Again, in government, the palace, whether royal or republican, despotic or democratic, has been always accounted good in proportion as it was artistic. All this has been for reason, and is not in error. It cannot be doubted that finance, the soul of modern industrial civilization, has a like interest in art, and with its own development will more and more recognize it.

Utilitarianism, on the other hand, has been fostered to the highest degree. Consider the enlargement of power (the power to do work in a limited time) given to an executive officer, when at his desk is placed a telephone with fifteen connections to as many departments of his bank, and beyond them to its affiliations beyond its walls, whereby he can obtain the execution of an order in the time formerly necessary to transmit it. And in the same direction other electric inventions help him : the light which comes at the touch of a spring ; the bell which calls attendance or help ; the elevator which makes a floor above or below as accessible as the principal one ; the alarm system which encases his vaults with a covering as deterrent to the robber as the fundamental steel. And so on downward to the devices used by the rank and file of the corporation : the steel cases which in the desk itself give security ready to hand, for records and documents, and save them from tedious and destructive transportation ; the screens and cages which separate departments without dividing them ; the counters and counter-screen which assist public communications, and from an undisciplined crowd evolve order and method ; the ventilating machinery which keeps a hundred men in health where without it twenty would suffer. In all these things there is without question a progressive vitality which needs no further stimulus,—with which, indeed, it is hard to keep pace.

It is worth while to let this review take a more concrete form, and examine an imaginary modern bank from the points of view already indicated as showing the chief aims of the machine. There is available a certain space limited by extent of land or by existing walls ; too often it is the latter, so we will accept that example, leaving for another place the consideration of the architectural advantages found in a separate building.

The first step in the process of specialization is to divide the space into two parts,—one for the public, the customers and their agents ; the other for the staff and employees. This is not so simple a step as it may seem, for all the further subdivisions will be affected by it for good or ill. Therefore, many things must be borne in mind, and none of them allowed to unduly obscure the others. A metropolitan commercial bank with numerous country affiliations will require a large proportion of space for its bookkeepers and correspondence and check departments, and relatively less for its counter customers ; while at the other end of the series a savings bank, with quarterly or other periodic dividend days, will need much more accommodation for its crowds of depositors and comparatively less for its bookkeepers. Between these extremes the bank of deposit and discount, serving a trading constituency, is likely to demand a large public department with numerous wickets for access to tellers and other clerks. For these reasons (and not for fancied preferences) various types have appeared in the arrangement of the main counter-screen. The simple straight line dividing a public lobby on one side from a clerical department on the other—the oldest form, an example of which is shown in Fig. 1—is still the best in many cases, especially in restricted dimensions. But often, in a wider building, more counter length is needed than the available length of the room; and it is then extended in various ways. An extreme method, admirable for spacious quarters, is to double it on itself in horseshoe form; then there results an inner and outer division, the latter usually of much the larger area. For the commercial bank the public lobby will be the inner or smaller division (Fig. 2); for a savings bank the outer one will be the best, especially where the business is regulated by dividing the customers (often of the

Fig 1



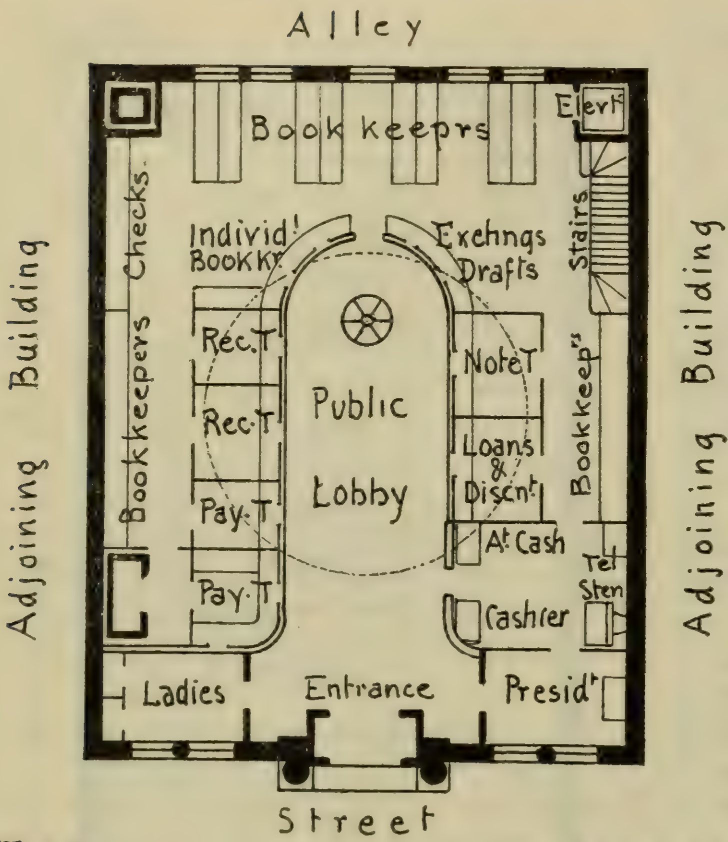


Fig 2 with Domed Skylight

poorer class) according to sex (Fig. 3). Sometimes a variation of the horseshoe plan (Fig. 4), or half of it, is better; sometimes a flattened or squared or modified form of its bend; or, in another case, a bay-like projection from a straight counter (Fig. 5). These are the usual types ot plans to vary the length in its relationship to areas of floor space. The selection will be made with reference also to the utilization of the daylight,—that valuable blessing which at the street level in large cities is getting so scarce and precious,—whether it comes from front, rear, or side, or from all of these points. The tellers and bookkeepers who spend the whole day in the bank should be granted the precedence in this regard over the customers and messengers, who are each accommodated for only a brief time. If there are (and there generally must be) some places less convenient, dependent partly upon artificial light, they can be used by those who will suffer the inconvenience for the shortest time. Next to the primary division comes the appropriation of certain spaces to the chief officers of the bank, and here we come to one of the modern developments of the subject. The old-time banks, with their special charters of authorized monopoly and the consequent assurance of business, did not find it necessary to court custom, scarcely even to meet it halfway, and the private bankers, whose position was achieved without State support, were ofttimes the agents of capital timid and hesitating in the insecure justice of imperfect laws; and both conditions naturally developed officers inaccessible and unsympathetic, by reason either of the superior advantage of privilege or of the vulner-

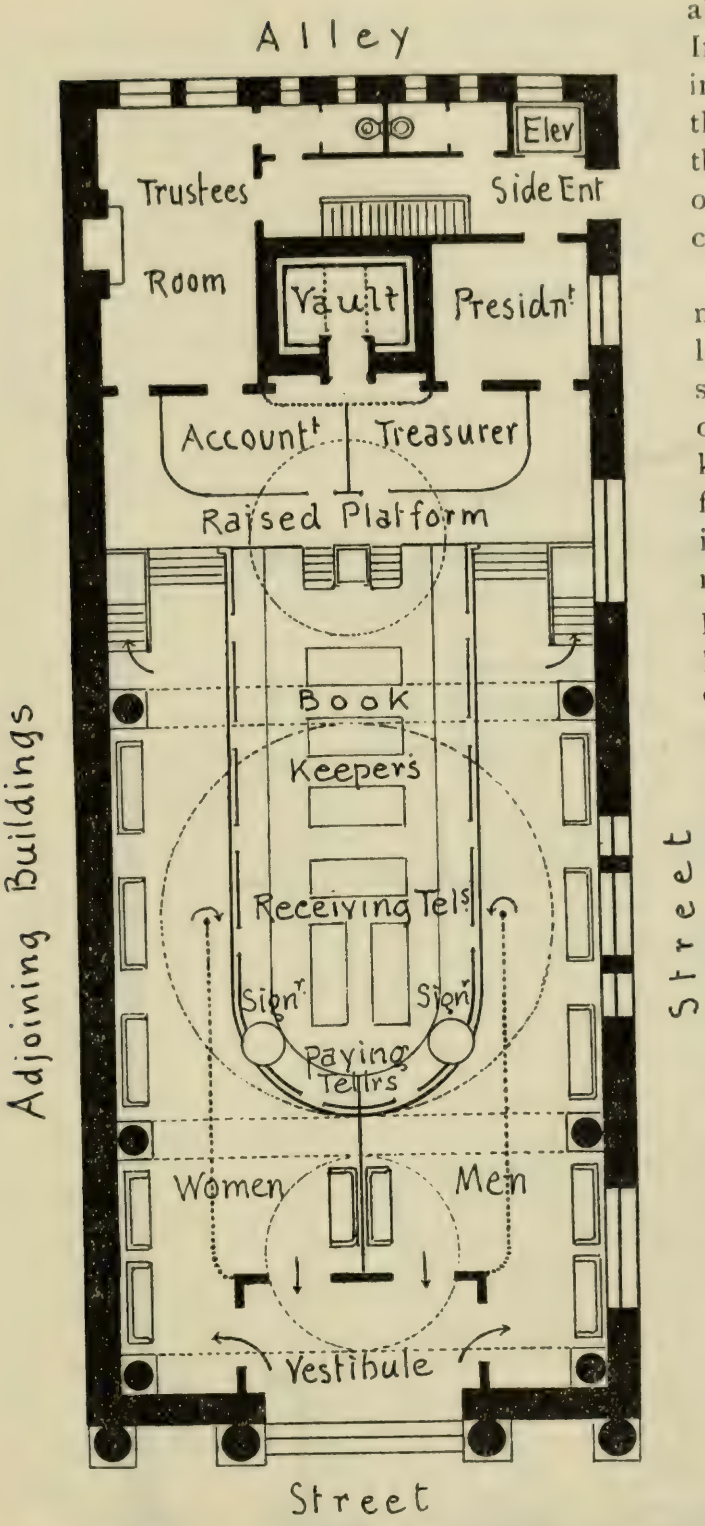


Fig 3. with Domed Skylights

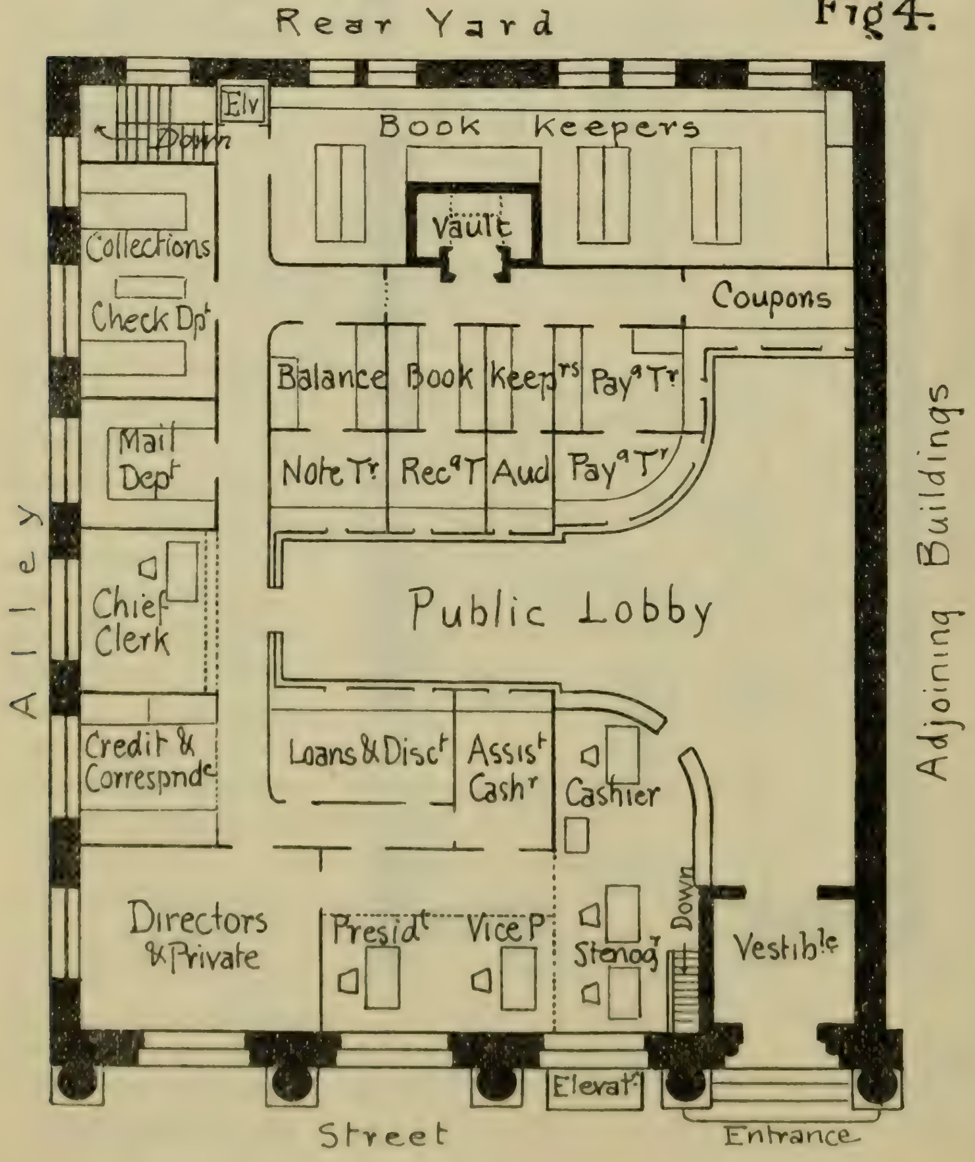
ability of weakness. In the atmosphere of industrial democracy this is so changed that the old methods of business have become obsolete.

The officers of a modern bank no longer seclude themselves in the farther chambers of a little known retreat or a fortified public building. Their departments would be half paralyzed by the slow process which fitted other times. The bank is a unit, organized to receive customers openly for immediate action. Its officers make themselves accessible, and place themselves in sympathetic contact with the world they seek to serve; and their staff is disposed so as to be quickly responsive to the master mind. Secrecy is dispelled by increased confidence in law and order. The guards and bars are erected against only the criminal classes, and are no longer needed to awe the community or resist its government.

The practical result of all this is that the officers' rooms of a modern bank are the first departments encountered upon entering it. They are separated only by low railings or parapets from the lobby, and visitors enter at will through a gate which has usually not even a latch.

Their proximity to the entrance and to the street carries with it the advantage of front windows and good light. There are still some cases in which the officers' rooms may be better arranged at the rear of the building, as in Fig. 3, which shows a plan for a savings bank demanding large spaces for crowds of depositors who do not need to see the officers and who can, therefore, be attended near the entrance and exit.

Fig 4.



From the chief officers the administrative work is transmitted to subordinate officers, who are consequently to be next considered and stationed conveniently near, and thence to various departments with more or less need of communication. Now, it is clear that the president or cashier desires *all* his departments accessible, but it is equally clear that some must be more remote than others. The question is which can best occupy the more remote places that have to be utilized somehow. This brings us to the problem of planning for internal facility. A large institution makes special allotments of space for the following departments: loans and discounts, credit and correspondence, mail, notes, auditor and passbooks, receiving teller, paying teller and safe, exchanges and collections, checks, bookkeepers, vouchers, and a few others of special nature, which may be grouped with one of the above. Often two or more of these offices are combined in one with advantage. In most banks the tellers are reponsible persons, whose work is systematic, and who can act without frequent special direction, while the loan and discount department is subject to continual special instructions, and must be in charge of the assistant cashier or other manager accessible to the chief. The loan department, therefore, is placed near the officers' rooms. The money department may generally be more remote, although it must, of course, be at the counter-front. So must the passbook department, which is frequently now made the office of the auditor, who, in recent systems of book-keeping, reviews and compares the work of the various subdivisions. This and the coupon and exchange departments are naturally associated with the cash tellers. The note teller is usually near the loan and discount division; see Figs. 2 and 4. Beside these, all of which need to be accessible to the public at the counter front, there have to be many bookkeepers stationed conveniently near and to the rear of them, so that the transactions of the counter may be entered in the ledgers without undue transportation of preliminary records. And, lastly, there must be spaces for those clerical departments needing no access to the public, including, near the executive, credit and correspondence, stenographers' and mail departments, and, more remote, the check desks, the collection department, the voucher clerks and files, stationery stores, telephones, &c. Sometimes the clerical force in this last group is placed in charge of a chief clerk, who is so placed as to command the entrance and receive messengers and others.

These arrangements represent, it will be seen, a very large bank,—a New York commercial bank, as we noted at the outset, and one, moreover, which does a large correspondence with country bankers. The plan shown in Fig. 4 is a good example; it is based upon the newly-constructed banking room of the Chase National Bank, New York city. For reasons which will be self-evident, it is not a plan of the Chase Bank, but only of a similar bank in somewhat similar quarters. It is also apparent that some of the special features of this plan would be unsuited to another bank. Here the practice of subdivision and isolation of departments is carried out according to the most recently advanced ideas. The great floor is spaced out, and each group is fenced or caged in with brass and steel open work with locked doors and rigid rules. Each room or cage has its telephone and "buzzer" (the electric call used in place of bell) from the executive, and "hand passes" or wickets for the transmission of papers, etc., so that there is little need for any man to leave his place. It will be noted that the daylight available, as shown on this plan, is better than usual in a New York bank ; this is assumed, in order to make a less complicated problem. The absence of the rear windows or the side windows would require radical changes in the plan, unless top lights were available. Nothing can be better for a banking room than a domed ceiling with a large central skylight, and, though the financial conditions which prevail in New York city make it seldom attainable, except by savings banks, yet, in places where real estate is not so expensive and so unavailable, there can be no better service rendered to a great bank than to give it a building with lofty proportions and a top light. Another point developed on this plan is the single entrance. To secure full supervision and safety, a good modern rule insists upon only one entrance to a bank (however large) from the exterior, and only one gate to the clerical department. Outside access to the basement may have to be arranged for a caterer or engineer, but even this should, if possible, be combined with the main entrance vestibule, or else made an elevator controllable by only one person. If there must be a rear or side door, it should be so planned as to be easily supervised, and should not lead directly to vaults or clerical rooms, but into engineers' rooms or locker rooms, dining rooms, or the like, and thence to the working places. Not only the ubiquitous sneak thieves, but the more ambitious robbers whose methods are a daytime surprise or a midnight burglary, are discouraged by a system which deprives them of the opportunity to make preliminary observations without attracting suspicion.

The plan shown in Fig. 2 is another form of a commercial bank. It is based upon the building lately erected for the Bank of Buffalo, and drawn so as to show the principles involved without actually publishing its arrangements. The horseshoe form of counter gives a long front affording numerous wickets. The departments are planned, as will be seen, on the same principles as in the other scheme, but with less subdivision. There is also a ladies' room, which is a feature not infrequent nowadays, when women show growing appreciation of the conveniences of a check book. This building has the advantage of a glazed dome, in addition to good window light. It has a gallery, accommodating the correspondence department; an upper story with directors' and other rooms; a basement with vaults and clerks' rooms, dining rooms, etc.; and some spare space.

Fig 5.

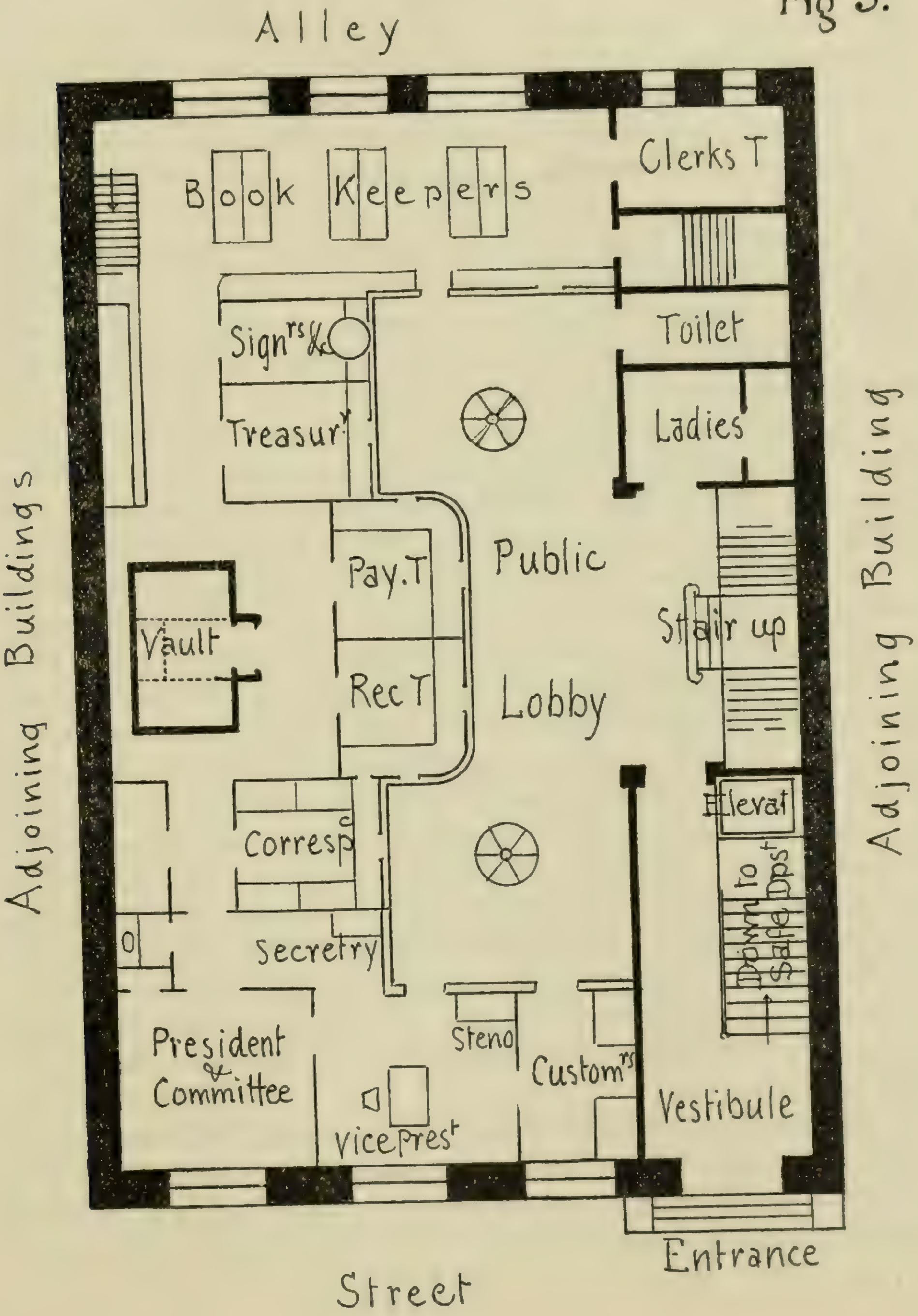


Fig. 1 shows a plan suitable for many busy banks in buildings of limited width and having only front and rear light; the same principles prevail, and need no further explanation than the names of departments upon the plan. This also illustrates the circumstances of an actual bank, although the plan is varied in certain respects.

Special and less regular arrangements are required by trust companies. The plan shown in Fig. 5 is an adaptation of that of the Rhode Island Hospital Trust Company, which does a large banking business at Providence. There is sometimes in a trust company's office less of the bank character than is here indicated. The officers are known by different names, and the business is with less hurried and less numerous customers. Sometimes, as in the United States Trust Company in New York, the counter screen can be dispensed with, and nearly all cages omitted with advantage. In fact, it is not possible to establish a type for these offices. The instance illustrated (Fig. 5) is of a building which has several rooms in stories above and a safe-deposit department in the basement; hence the need of two or three staircases. Daylight is obtained from a top skylight as well as from front and rear windows.

The savings bank plan, shown in Fig. 3, is a condensed adaptation of the Greenwich Savings Bank, New York. This is a good example of a class entirely different from those already described. The numerous depositors have to be marshalled by guiding rails leading them from the entrance lobby to the receiving teller or to the pass-book and signature clerks, and thence, for withdrawals, to the paying teller and the exit, by doors separate from the entrance. The public lobby of a savings bank must be liberal in size, and, therefore, the outer division of a horseshoe plan of counter-front is often devoted to that purpose. This also facilitates a useful seperation of the two sexes, grouped on both sides of a central tellers' department.

The bookkeepers occupy the middle space. The loan department is practically the offices of the treasurer and president, where the quieter business, usually in negotiations for large sums borrowed on mortgages, requires accommodation entirely different from that afforded by the loan offices of a commercial bank.

These five examples are types of floor arrangement upon which modifications for local details are engrafted to suit nearly all the modern requirements.

The details of other parts of the buildings—the vaults and clerks' accommodations, storage, and so on—and the consideration of the constructive and artistic elements of the building itself will be treated in a future paper.

PROSPECTING WITH THE DIAMOND DRILL.

By J. Parke Channing.

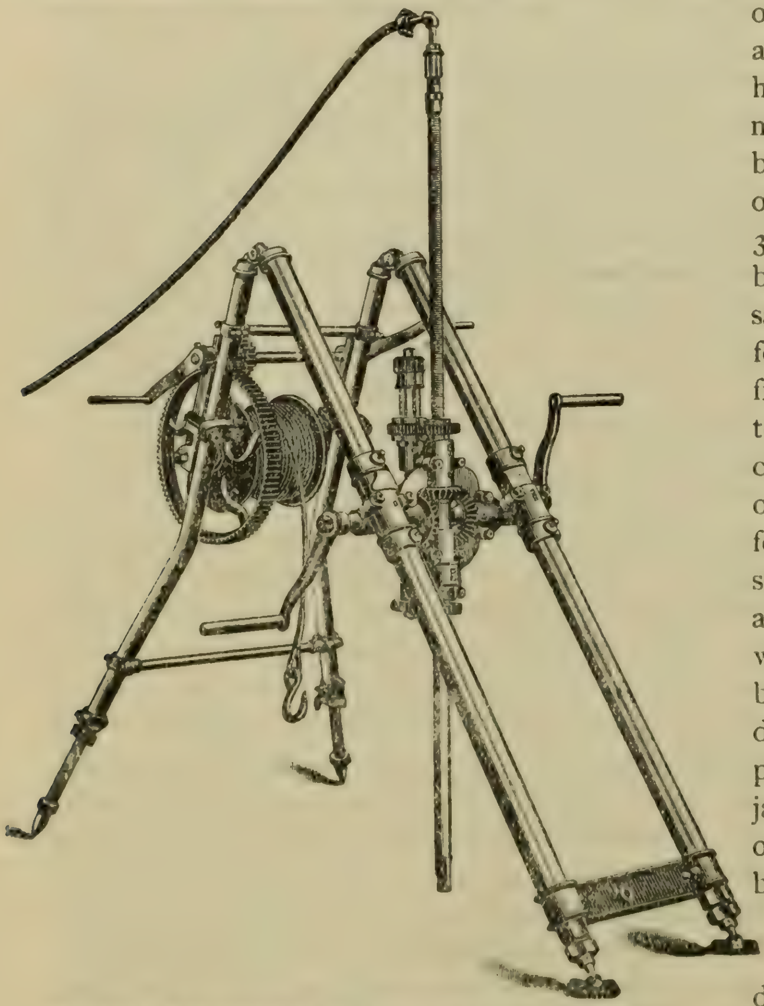
WHILE the diamond drill is principally used to determine the character of the ground passed through, such is not always the case. Holes may be put down from the surface to strike water, brine, gas, or oil; to afford access to a mine for steam pipes, air pipes, or electric wires; or to conduct water to fires in the workings. Holes started underground may be drilled for ordinary charging and blasting with powder; to tap the water from adjoining workings on the same or a higher level; to afford a passage for pipes or wires; or to act as pilots, in case the workings are approaching any place from which an outburst of water or gas is expected. In the Lake Superior district the usual size for holes up to 500 ft. in depth is about 1½ in. removing a core 1 in. in diameter. The next size is a 1¾-in. hole with a 1¼-in. core, and for very deep holes a 3-in. hole with a 2-in. core. For special purposes holes have been drilled as much as 16 in. in diameter, with correspondingly large cores.

From the following notes on diamond-drilling a detailed description of the machinery and accessories is omitted, since they are familiar to engineers and others who have had experience in this line of work, while published descriptions are readily accessible to all who may wish to inform themselves as to these details. Only such points will be here considered as, it is thought, may prove useful in practice.

There is not much difference in the practice of underground drilling as compared with "shanty" or surface drilling. In underground work one drills flat and upwardly-inclined holes as well as vertical and downwardly-inclined holes: the latter, however, are the only holes drilled from a shanty. Underground the back or roof of the level or stope furnishes a place for attachment of the hoisting sheave, a pipe from the pump column the water, and a hose from the compressed-air pipe the necessary power. Surface drilling is generally done in places remote from water or air under pressure, and requires a complete outfit. As a rule, the rock surface is covered with earth or glacial drift (a material entirely unsuited for diamond drilling), which must be penetrated and held back till the solid rock is reached. If the surface is light, or if it is desired to drill many radiating holes from a single point, a pit or shaft is sunk.

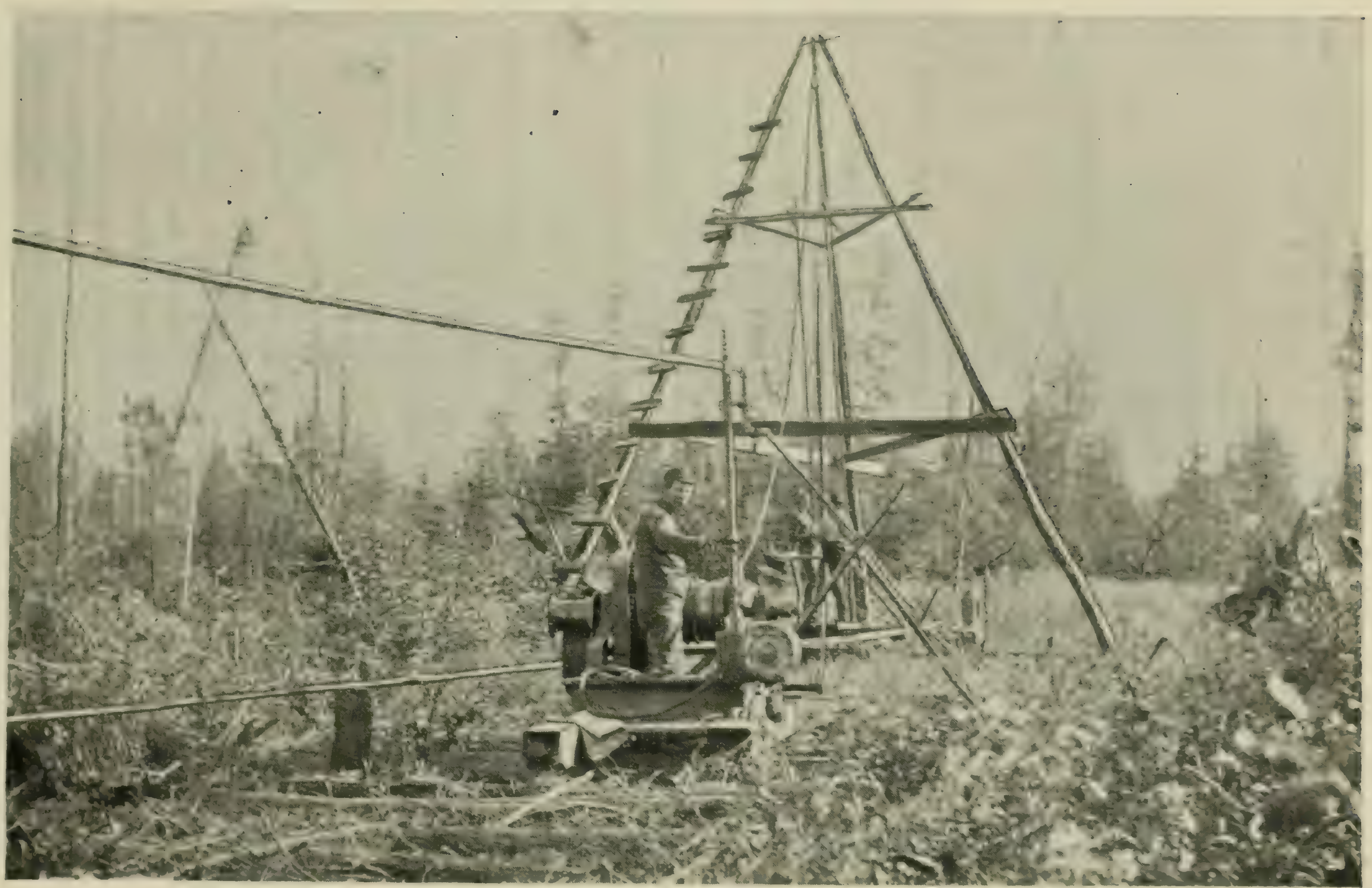
This may be a simple pit, with nothing but a little curbing of light plank to prevent its caving, or it may be a fair-sized exploring shaft work with steam hoist and steam pump. If the loose surface is deep,—say, over 15 or 20 ft.,—or, if the natural water level is high, it is necessary to drive down a standpipe to the rock, through which the drill rods may be introduced. A loose sandy or gravelly soil is best for driving pipe. Boulders retard the progress of the pipe, and often entirely block its progress, so that several attempts in approximately the same position must be made to get the pipe down to ledge.

This driving of standpipes is one of the most indeterminate items in the cost of diamond-drill work, so much depends on the character of the ground. With a drill-runner, a helper, and a fireman, and a boiler burning half a cord of wood a day, a 35-ft. standpipe can be put down, in sand and clay with few boulders, in from two and a half to three shifts, at a cost of not much over 50 cents per foot. It took six shifts to put down a standpipe 37′ 4″, where the first pipe broke when 31′ 9″ down, from which point blasting in jasper, loose ledge, or boulders had to be resorted to. As an extreme case, a standpipe was driven 96 feet through coarse gravel with many boulders in two months, working night and day. This was a total of one hundred shifts. The pipes broke twice, and had to be pulled out and re-driven. Many boulders were drilled and blasted. The total cost was approximately $7 per foot. This was an exceptionally hard hole, and shows what one may encounter. On the contrary, standpipes have been put down in swamps 50 and 60 ft. in a few hours.



SULLIVAN HAND-POWER DIAMOND PROSPECTING DRILL.

Capacity 300 ft.; Hole $1\frac{1}{2}$″; Core $1\frac{5}{16}$″.



SINKING A STANDPIPE BY THE USE OF A PORTABLE HOIST.

Photographed by Geo. Gibbs, M. E. of the C. M. & St. P. Ry. Co.

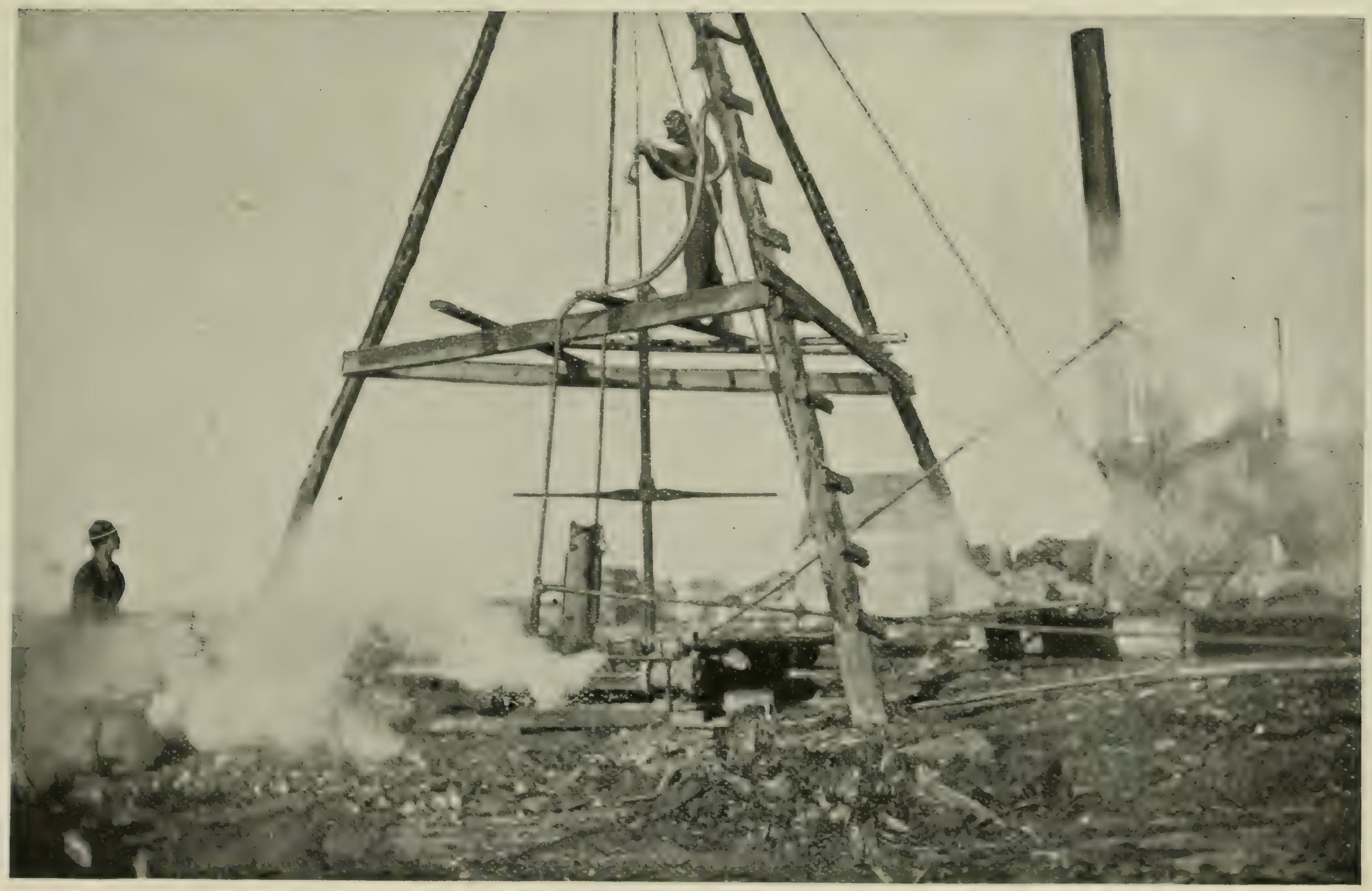
the only difficulty being with the layer of boulders on top of the ledge.

Having driven a standpipe to the ledge, and cut off the sand from coming in by drilling a casing into the solid rock a few inches, the drilling proper begins.

It is at this point that conditions are most favorable for the drilling. The hole is clean and, the character of the rock being known, the drill runner has set his drill for the correct feed. The drill is given enough steam to keep it up to the regular speed, which would be about 200 rev. per min. The speed of the pump is so regulated that the cuttings are washed up through the casing without clogging ; a velocity of 12 in. per second will assure this. If everything continues favorable, the drill may run till the core barrel is filled. The guides which the drill runner has are the speed of the drill and the flow of the wash water. If the bit encounters harder rock, the resistance will be greater and the drill will slow up, and *vice versa.*

If perhaps, as is constantly occurring except in the massive rocks, the core, because of slips, seams, and alternation of hard and soft material, becomes clogged in the bit, the core shell, or the barrel, there will also be a retardation of the speed of the drill because of the extra energy consumed in grinding away the core. This effect may be differentiated from a change of ground by noting the overflow water. The passage in the bit being clogged, the overflow will be diminished, and the pump will slow down and labor. In the latter case it will be necessary to pull the rods, uncouple the bit and core shell from the barrel, and, with a few smart blows of a hammer, dislodge the core.

If, after the hole is down some distance, it has passed through a layer of porous or broken ground, it may happen that the water is "lost,"—that is, has gone down through the rods and returned up the hole to the broken zone, where it becomes dissipated, little or none reaching the top of the hole or surface. In such cases the drill runner must have a pressure gage on his pump to inform him when the bit becomes blocked. Lost water is not very desirable, and many devices are resorted to in order to fill up the cracks. Among these are the sending down of liquid cement or of material like bran. In boring in certain hard rocks it occasionally happens that a piece of core is divided by a slip making an acute angle ; the two wedges slip by each other, binding the core tightly, and yet not cutting off the flow of water. In cases like this the runner must take into consideration the condition of his bit. If his experience shows that a bit should cut 5 ft. in the rock before it becomes dull, and this slowing up of the drill happens after only 2 ft. have been drilled, the presumption is that some core has become wedged. A temporary blocking will often give

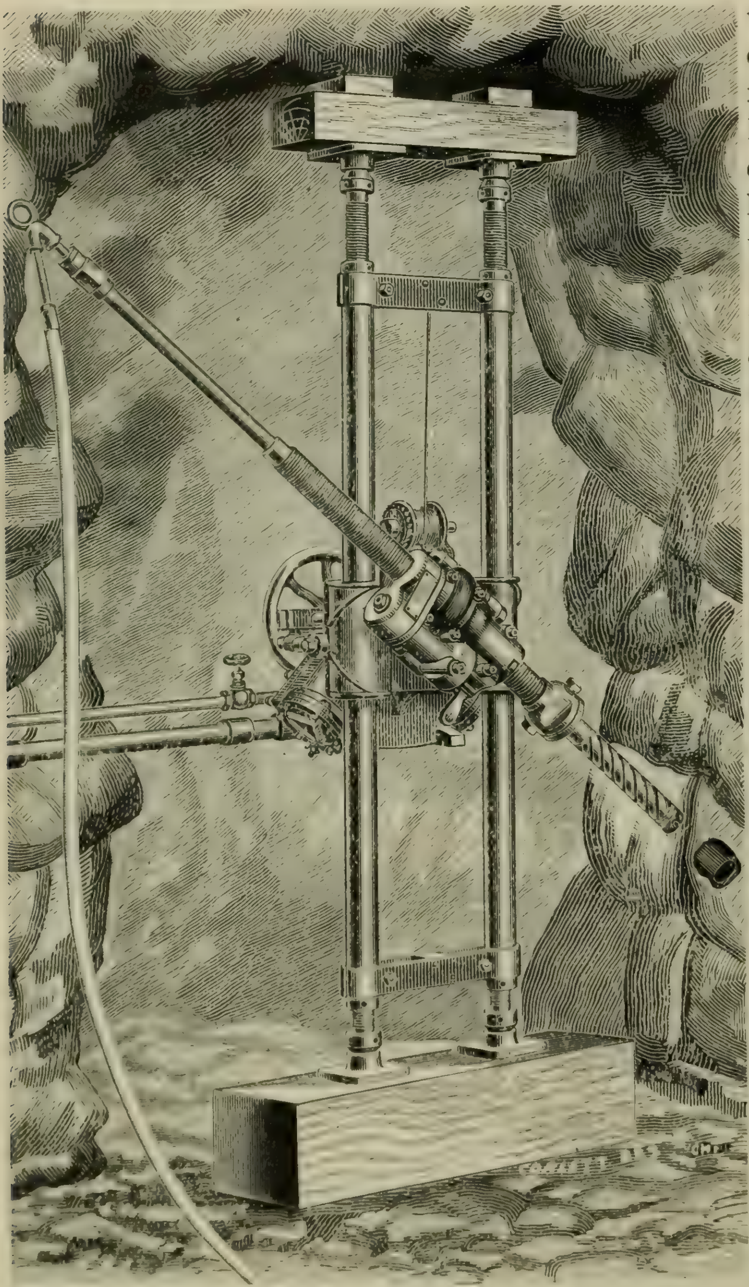


SINKING STANDPIPE.

Photographed by Geo. Gibbs, M. E. of the C. M. & St. P. Ry. Co.

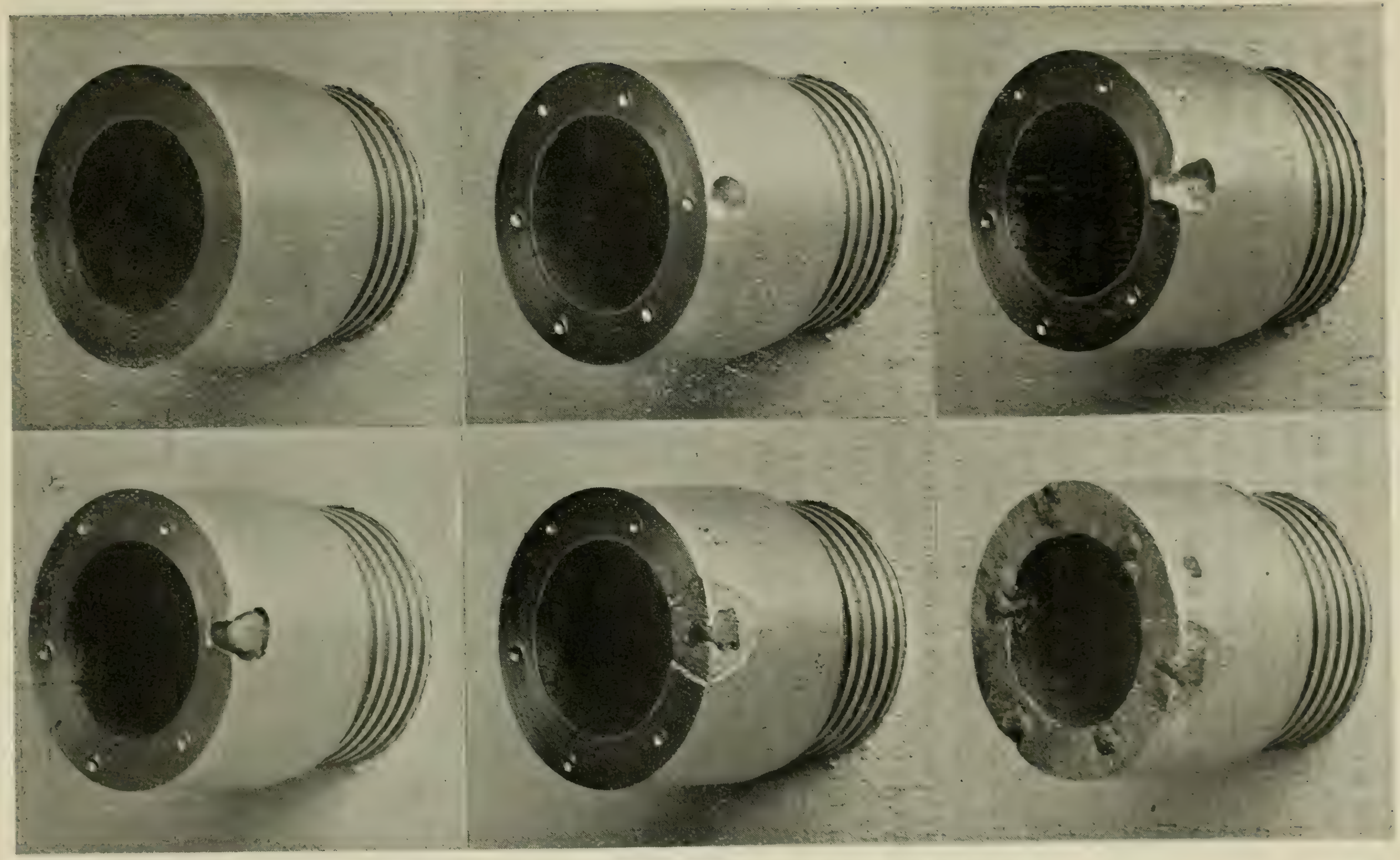
way after further drilling, but the runner must learn by experience in different kinds of ground what to expect.

If a rod were to twist off in drilling, the drill would speed up, and the water, having a freer course, would allow the pump to increase in speed and discharge. If, when the rods are hanging from the machine and the bit is off the bottom of the hole, the rods rotate with difficulty and in a jerky manner, it is an indication that some foreign material, such as sand, gravel, or fragments from the side of the hole have got in between the rods and the hole.



BULLOCK DIAMOND DRILL UNDERGROUND SET FOR A 45° DOWNWARD HOLE.

The runner should note the depth of the hole, when changes in speed occur which may indicate change of ground; also changes in the appearance of the wash water, remembering that a certain time elapses, after a change of ground is encountered, before the cuttings come up. Foreign material, such as drops of candle grease, is often run through the rods to give a rough idea of how long it takes the wash water to make the circuit from swivel to overflow pipe. The

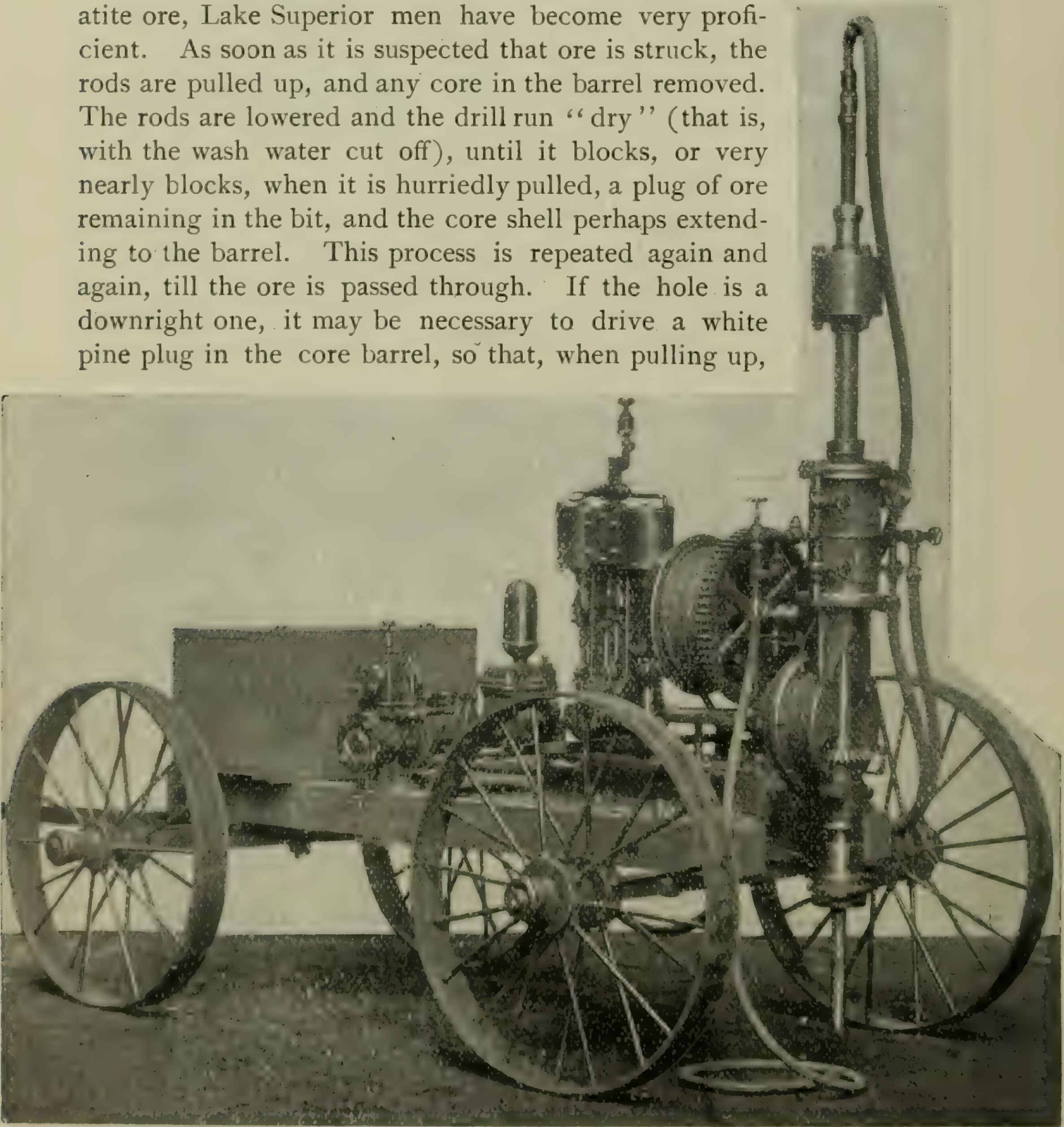


VIEWS OF BIT IN VARIOUS STAGES OF SETTING THE CARBONS.

1. Blank bit.
2. Bit marked and one hole drilled.
3. Hole enlarged by chiselling.
4. Carbon placed in the hole.
5. Carbon caulked in place.
6. Finished bit showing six regular stones and one of the two clearance stones.

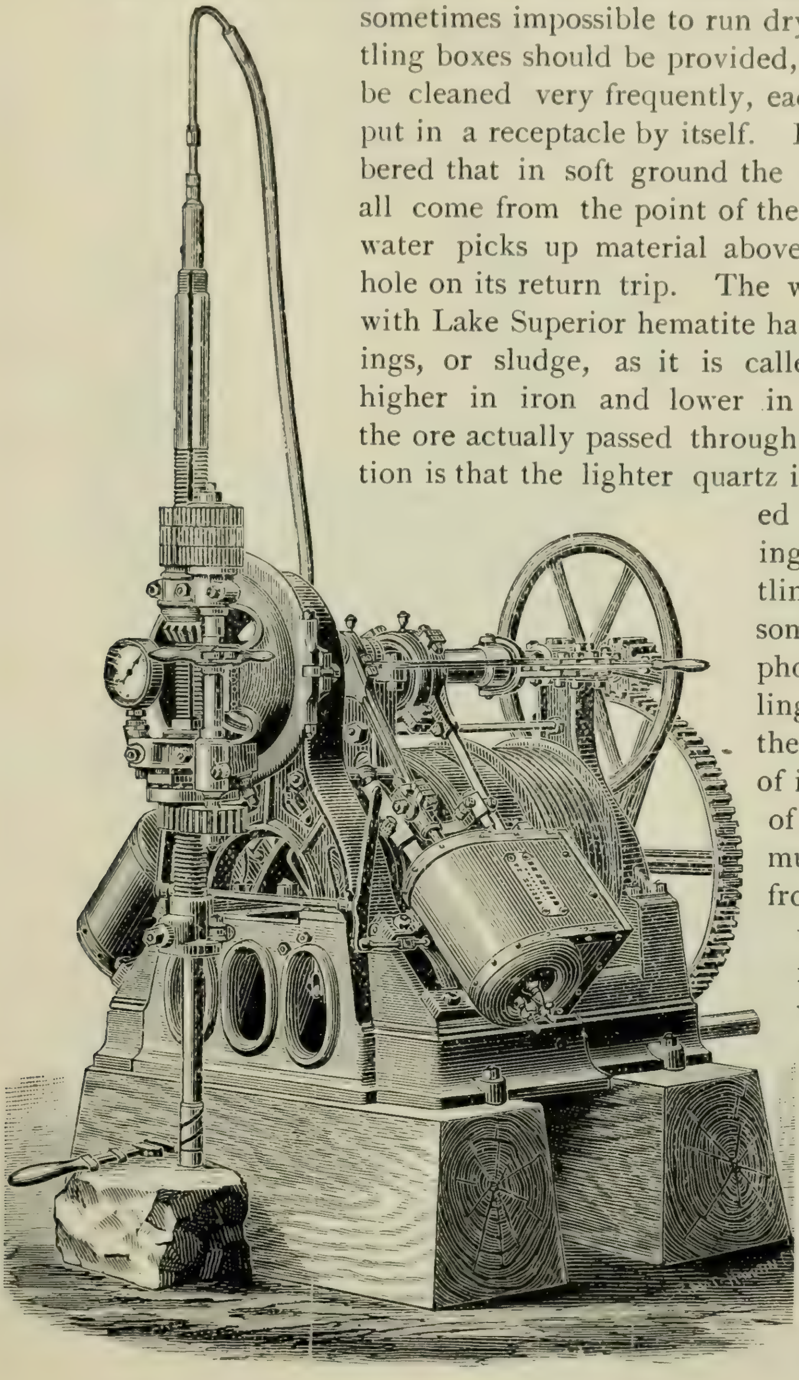
Though the courtesy of Messrs. Olaf Hallgren Setter, and W. H. Johnston, Supt. Lake Superior Mine.

reason that it is necessary to take these precautions is that, if 10 ft. of ground is drilled, the total core secured may be only half that length; nor will the pieces be proportional to the length of each kind of material. The harder pieces of core will wear away the softer, and remain more in evidence. The prevailing idea is that soft material cannot be made to furnish a satisfactory core. This is a mistake; double core barrels (in which the wash water passes down through the annular space) are made, and also core lifters that do not come in contact with the core till the rods are pulled. In drilling in soft hematite ore, Lake Superior men have become very proficient. As soon as it is suspected that ore is struck, the rods are pulled up, and any core in the barrel removed. The rods are lowered and the drill run "dry" (that is, with the wash water cut off), until it blocks, or very nearly blocks, when it is hurriedly pulled, a plug of ore remaining in the bit, and the core shell perhaps extending to the barrel. This process is repeated again and again, till the ore is passed through. If the hole is a downright one, it may be necessary to drive a white pine plug in the core barrel, so that, when pulling up,



A PORTABLE DIAMOND DRILL (SULLIVAN) FOR SURFACE WORK.

the column of water in the rods will not force out the plug of ore. This process is slow, but gives one an accurate record of the ore. It cannot be impressed too strongly upon drill-runners that accuracy must never be sacrificed to speed. In soft ground great attention must be paid to the cuttings, as in an ore with hard and soft parts it is sometimes impossible to run dry. A series of settling boxes should be provided, and these should be cleaned very frequently, each cleaning being put in a receptacle by itself. It must be remembered that in soft ground the washings will not all come from the point of the hole. The wash water picks up material above the point of the hole on its return trip. The writer's experience with Lake Superior hematite has been that drillings, or sludge, as it is called, are generally higher in iron and lower in phosphorus than the ore actually passed through. The presumption is that the lighter quartz in the ore is washed away in the tailings from the settling boxes, as also some of the phosphorus. In sampling hematite sludge the metallic particles of iron from the wear of the rods and bit must be removed from the powder with a magnet before the chemist weighs out the charge for analysis.

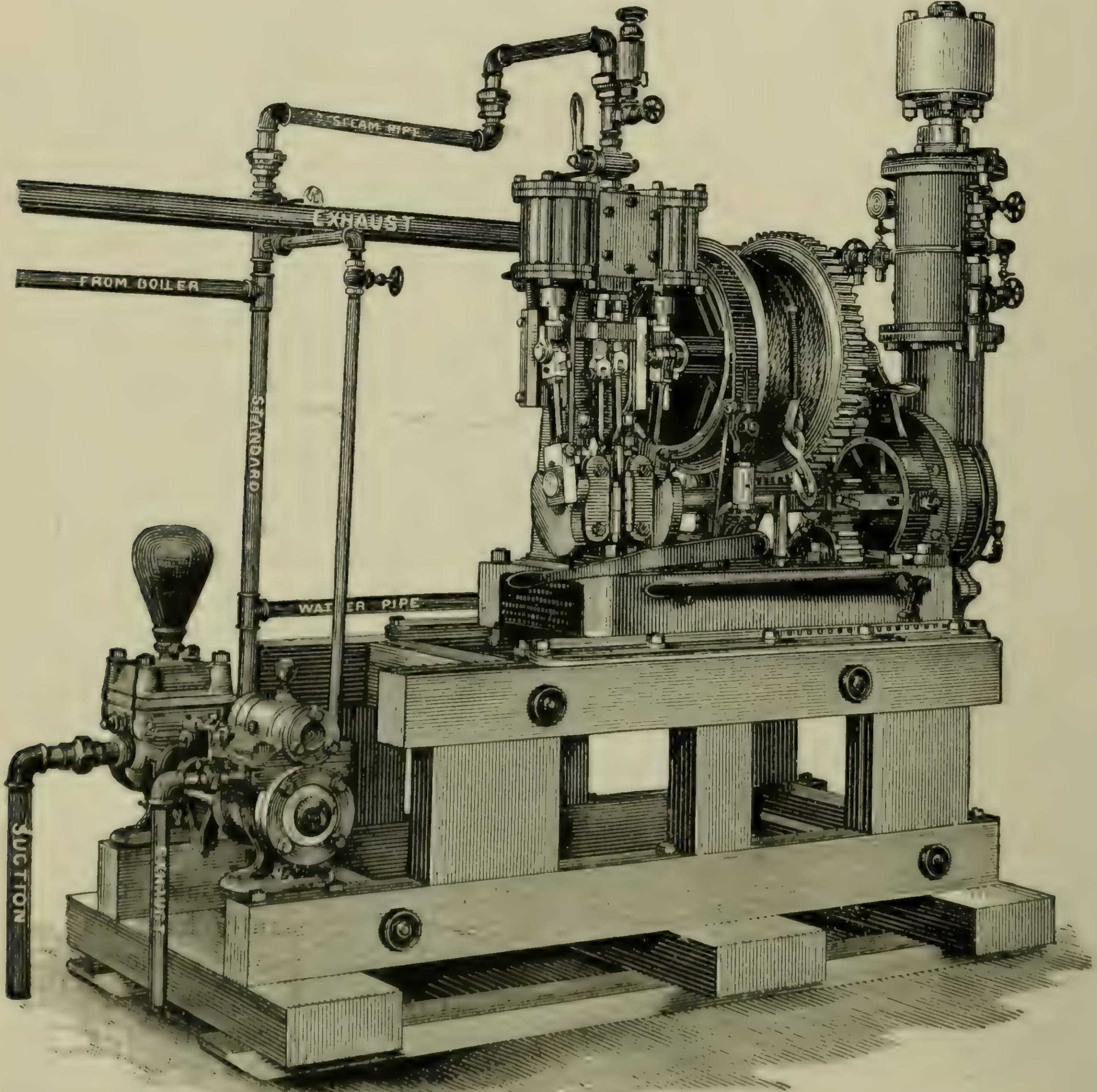


BULLOCK DEEP-HOLE DIAMOND DRILL.

Capacity 2500 ft. ; core $1\frac{7}{16}$".

A good runner should constantly have his two-foot rule at hand, and know accurately the depth of the hole when he stops drilling. He must be sure that, before starting to drill again, the bit is down on the bottom of the hole, and not resting on a piece of loose core or a caved-in piece of rock. Nothing cuts up a bit like a piece of loose rock swirling around like a cannon ball in a pulverizer. Careless running in broken ground and trying to "tong" a bit down a hole that is too small for it are liable to break diamonds. The hole also must be kept to gage.

As holes become deeper, the time spent in lowering and hoisting increases. For example, in a certain hole at an angle of 45°, when 310 ft. deep, it took 15 min. to lower and 25 min. to hoist; when the



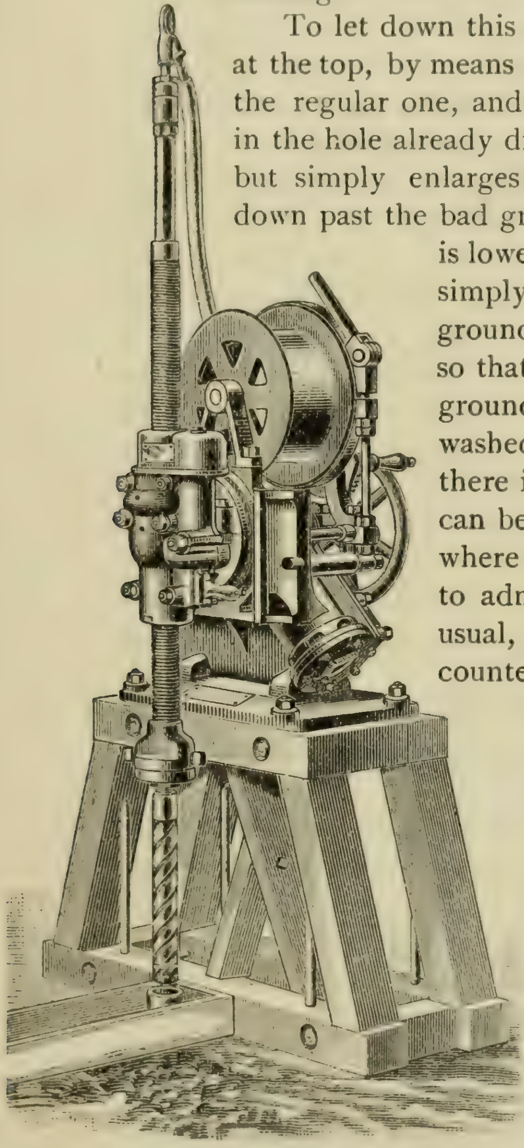
SULLIVAN DIAMOND DRILL MOUNTED ON FRAME, WITH HYDRAULIC FEED AND DRUM.

hole was down 531 ft., it took 30 min. to lower the rods and 45 to hoist. This was at the bottom of a pit, and only 10 ft. of rods could be handled at a time. On very deep holes it is advisable to build a tower, like those used in oil-well drilling, so that the rods can be uncoupled in long lengths.

If, after going through hard formation, a soft, caving ground is struck, it often becomes necessary to shut off this soft ground with a pipe called a casing. This is simply a strong pipe, threaded inside at one end and outside at the other, so as to make flush joints. It is of sufficient internal diameter to permit the passage of the regular bit used in drilling.

To let down this casing, the hole is enlarged, beginning at the top, by means of a reamer. This is a bit larger than the regular one, and provided with a guide in front fitting in the hole already drilled. The reamer produces no core, but simply enlarges the hole. The reaming is continued down past the bad ground, and, when completed, the casing is lowered. It is seldom that this casing can simply be lowered down, except in solid ground. It is usual to put a bit upon its end, so that it can be drilled down through bad ground. Its core, if any, is chopped up and washed out. On the European continent there is in use an expanding reamer, which can be sent down inside a casing past its end, where it will ream out a hole of sufficient size to admit the casing. In this country it is usual, if a second run of bad ground is encountered, to send down a second smaller casing, or else withdraw the one already in, while the hole is reamed to a greater depth.

The mishaps that may occur in drilling are many. The most common is the parting of the rods while in the hole. This may come from a fracture of the rods, the stripping of a thread, or the unscrewing of a coupling. The last is more liable to occur when pulling the rods than at any other time, and may result in smashing a set of stones. If rods are simply uncoupled, they can usually be caught by gently



BULLOCK DIAMOND DRILL FOR SURFACE PROSPECTING.

lowering and entering the top piece, and turning it to the right. In cases of fractures various sizes of inside and outside recovery taps are provided. The writer once spent two days in recovering a bit in a flat hole where the core shell had twisted off at the core lifter ring and left the ring in the lower half of the shell. The recovery tap entered the ring, which was so hard that the tap would not catch it, and yet it would twirl around with the tap, preventing the tap from advancing and catching the inside of the shell. After cutting several portions from the end of the tap, it finally caught the top of the broken shell with one thread and pulled it out.

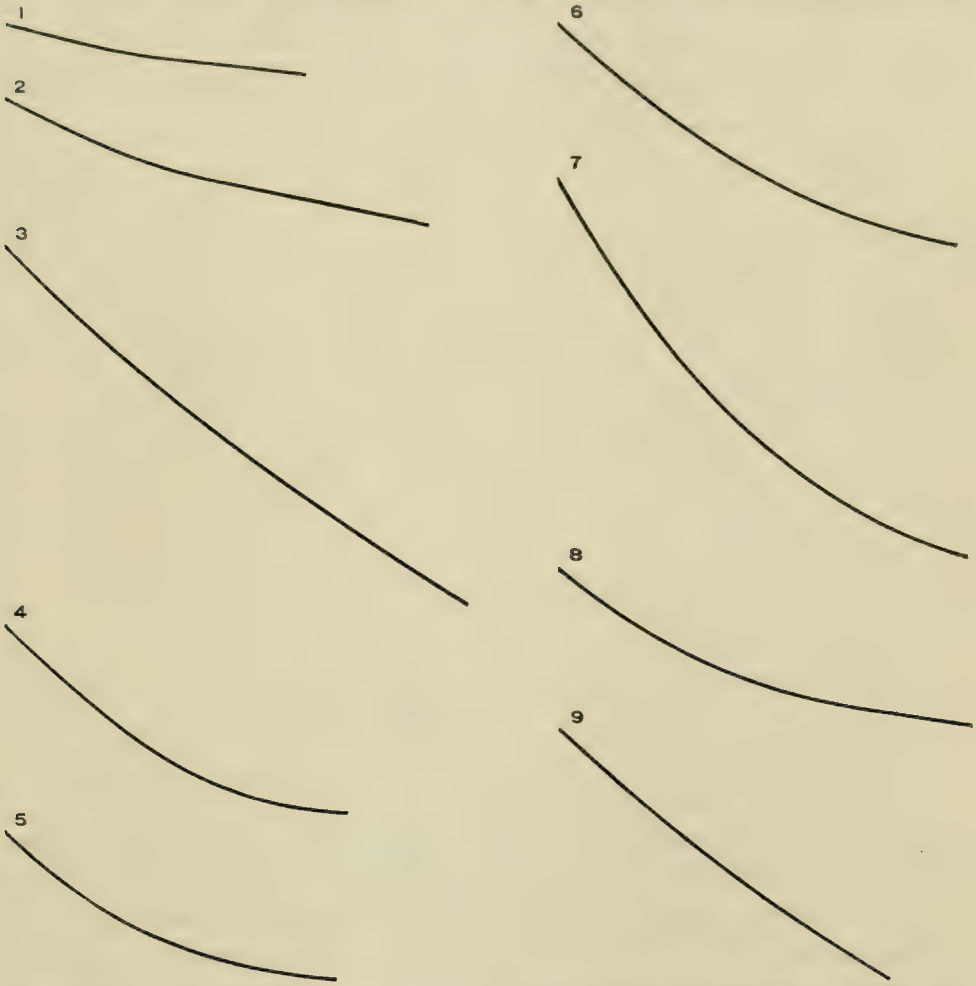
When casing or rods are fast in a hole near the bottom, that portion above the obstruction can be removed with a left-hand tap. In using left-handed taps the right-handed rods must be pinned at their joints to prevent unscrewing. Fishing for broken rods is much complicated in cases where the ground is soft or caving and large chambers have been washed out in which the end of the rod may rest and the tap pass by it. It sometimes happens that a diamond is wrenched loose from its setting and remains at the bottom of the hole, either unbroken or in several fragments, when the rods are withdrawn. In cases of this kind the bottom of the hole should be cleaned out by a mass of soap or wax attached to the end of the rods and lowered in the hole. The fragments of rock and carbon will adhere to the sticky material, when it is withdrawn. If caving ground catches the rods above the bit, they may be released by drilling down a casing outside of the rods and cutting away the bound rod with a steel rose bit.

Overcoming difficulties at the bottom of a deep hole will tax the ingenuity of a good runner and show his capacity. No man should undertake a deep hole—one over 750 ft.—who has not had a good experience with shallow holes.

In prospecting for ore the value of a diamond-drill hole does not depend upon the fact that so many feet have been drilled, but upon an accurate knowledge of the strata passed through. To this end the cores should be carefully saved and put away in racks for reference. In drilling through long distances of the same barren material, it is not advisable to retain all the core ; only a proportionate part need be retained. The racks are flat boxes, generally a foot wide, six to ten feet long, and one to two inches high, according to the size of the core. The interior is divided by thin longitudinal strips into spaces as wide as the core is thick. Little square blocks of wood should be inserted from time to time in the spaces between the pieces of core on which the depth of the hole at that point is marked. In addition to this, the head drill runner should keep a note-book, in which he records changes of ground and all items of interest. In mine work blanks are often provided, on which the runner makes daily reports of his work to the office.

The engineer in charge of the work should locate the collar or top of the hole with reference to some permanent mark, giving the course and the angle from the horizon at which it was started.

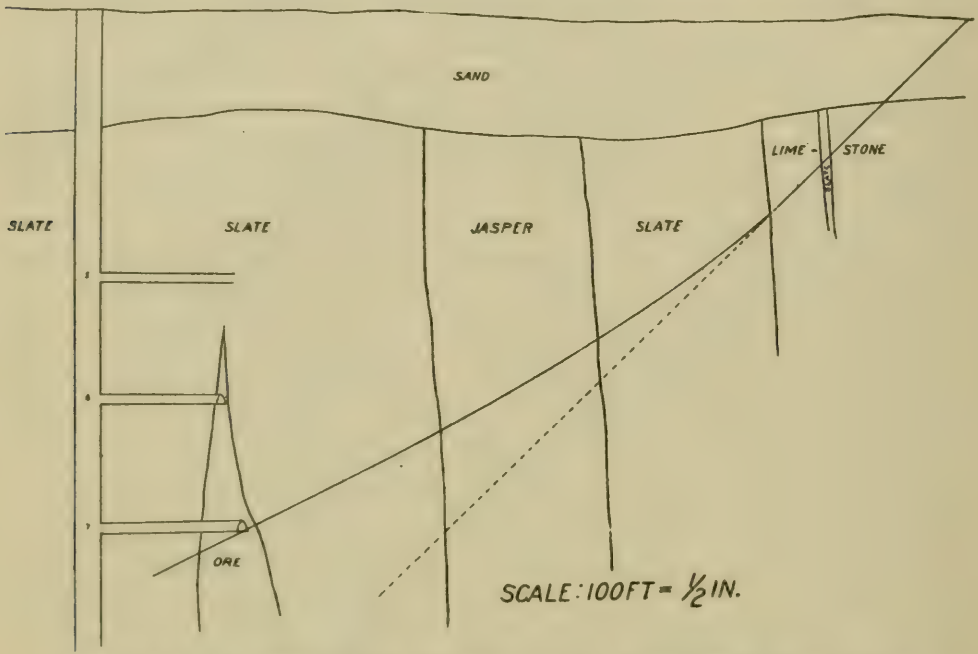
It has generally been supposed that drill holes continue on the course upon which they were started. This is not so. The divergence will depend upon the nature of the ground and the condition of the boring tools. If the hole is laid out vertically, it is liable to take a spiral course, or perhaps run off in one direction. At one of the Cliffs Shafts in Ishpeming, Mich., a vertically-started hole at a depth of about 400 ft. was some 15 or 20 ft. out of plumb. Mr. C. Le Neve Foster notes two marked cases. At the Scotchman's United mine, Victoria, a diamond drill-hole 370 ft. deep was deflected 37 ft. 3 in. At the Oriental Company's mine a hole 425 ft. deep was 60 ft. 9 in. out of



PROFILE SHOWING CURVATURE OF HOLES SURVEYED BY J. PARKE CHANNING.

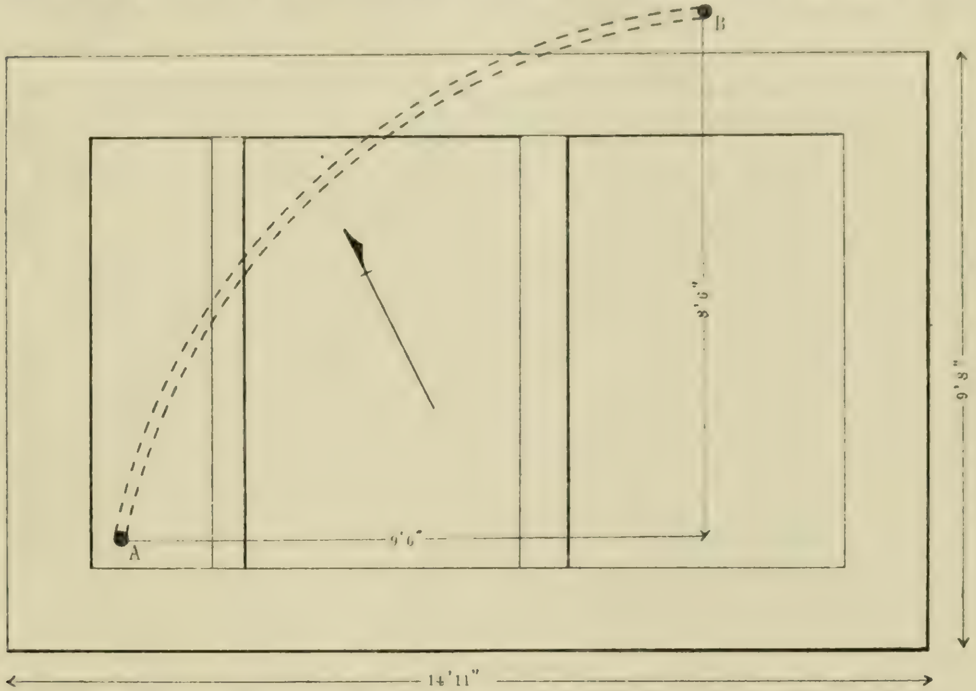
its proper course. Hughes mentions a hole at Dienslaken that varied 47° at a depth of 750 ft. A hole at Leith in Holstein, went spirally and at a depth of 984 ft., varied 3° from the vertical.

In a similar manner inclined or flat holes will vary. In 1893 the writer tested nine holes which he had drilled in Michigan. These holes were laid out at angles varying from 15° to 60° from the horizontal, and the variations at the bottom were from 11½° to 42°. It was invariably found that this variation was in the line of flattening. A hole started at an an angle of 45°, when down 353 ft. had flattened to an angle of 3° from the horizontal, and another, started at 60°, had, at a depth of 576 ft., flattened to 18°. Capt. Peter Pascoe of the Republic iron mine, Michigan, reported that in his mine "horizontal holes invariably raised as they gained in length."



CHAPIN MINE, CROSS SECTION THROUGH "D" SHAFT AND DRILL HOLE.

At the Chapin mine, Iron Mountain, Michigan, a drill hole north of the present "D" shaft was put down at an angle of 45° pointing south. It struck ore at about 725 feet., or what should be the eighth level of the mine. After the shaft had been sunk and the drifts run out, the hole was encountered on the seventh level, 96 ft. higher up and 70 ft. further south than the supposed position. This flattening is due to the flexibility and weight of the drill rods and their smaller cross-section as compared with that of the bit. The rods and core barrel lie on the lower side of the hole, while the bit fills the end. This causes the line of boring at any period to make an angle with the axis of the hole in which the tool is rotating, thus making the line of advance an upward curve. It has been found that, when the clearance on the bit is a minimum and the core shell and the core barrel are renewed as their wear becomes noticeable, the holes keep much straighter. Calculations show that in some cases the whole of the difference in diameter between the bit and the core barrel produces its effect in less than 20 in. back of the bit. The writer suggests that, in case it is desirable to keep this curvature at a minimum, a bushing set with carbon and of the same gage as the bit be used between the core shell and the barrel. The influence which alternation of hard and soft material has upon the deflection of a hole has not been positively determined. Claims are made that the hole will have a tendency to run parallel to the formation, and equally strong are the claims that it tends to assume a position at right angles. In very soft caving ground, such as hematite ore, the hole is liable to drop down, instead of curving up. This is due to the washing away of the material on all sides of the actually-drilled hole. Most drill runners are very indignant, if it is suggested that drill holes do not run staight, but the fact nevertheless remains. If a few hundred feet of rods are laid out on the ground in curves, it will be seen how flexible they are, and how easily rotated, in that position. If this curvature is determined and allowed for, the results of drilling will be greatly increased in value.



PLAN OF NO. I SHAFT, HAMILTON ORE CO., IRON MOUNTAIN, MICH.

A. Location of drill hole at surface. B. Place where hole disappeared, 490 feet below surface. Dotted lines show course of hole for the 490 feet.

In 1880 G. Nolten of Dortmund, Germany, proposed the use of glass tubes containing hydrofluoric acid. These were lowered down the hole and left until the acid had etched a ring on the sides of the glass. On withdrawing the tube and holding it so that the top of the liquid coincided with the etched line, it would be held at the same angle as when in the hole. This was the method employed by the writer in Michigan.

In 1883 E. F. Macgeorge, an Australian engineer, invented and used tubes filled with gelatine, in which delicate glass plummets and small magnetic needles were suspended. These were heated to a temperature of 180° F., which liquefied the gelatine. They were inserted in the hole at various points, and left in until the gelatine solidified. On being removed from the hole, the angles made by the plummet and the compass with the axis of the tube were measured, and the results plotted on the map. In those districts where magnetic material in the rocks deflect the needles irregularly, the compass cannot be used. This would be the case in most of the Lake Superior district and in all the New Jersey magnetite mines. Nevertheless, in important holes the measurement of the vertical angles alone will be of great value.

It is on the continent that the deepest drill holes have been put down. The hole at Paruschowitz in the district of Rebnik, West Silesia, was started with a bore of 11.8 in., and, at a depth of 6,568 ft., had been contracted to 2.8 in. It is proposed to put this hole down 8,000 ft. At Schladenbach a hole was put down by the Prussian government in search of coal, mostly through sandstone. It was begun in June, 1880, and, after a year's work, abandoned till the end of 1882. In January, 1885, it had reached a depth of 4,600 ft., and the cost up to that point was about $25,000.

In South Africa, on the Witwatersrand, the Simmer & Jack Company put down a hole which struck the main reef at 2,391 ft. This was one of the most important holes on the Rand, and showed a reef 9 ft. thick, assaying 1 oz. 15 dwts. of gold.

The Minnesota Iron Co. drilled a hole at Soudan, Minn., which was 2,208 ft. deep. The deepest incline hole on Lake Superior was probably one in the Lake Superior mine at Ishpeming, about 1,000 feet, at an angle of 30°.

Improved machinery and experience in drilling have tended to the use of smaller holes, which, of course, are much cheaper than those of larger diameter. In holes not more than 750 ft. deep it is much cheaper and speedier not to use a bit over 1½ inches in external diameter. For coal or friable material this rule would not apply.

The tabular cost statements which accompany this article are self-explanatory.

RECORDS OF COST IN DIAMOND DRILLING.

TABLE I.

	5 Holes 1066 Feet		1 Hole 1293 Feet		3 Holes 478 Feet		5 Holes 780 Feet		1 Hole 216 Feet		1 Hole 174 Feet		2 Holes 267 Feet		3 Holes 410 Feet		Total	
	Sandstone & Marble		Black Slate & Jasper		Jasper, very hard		Jasper hard..		Iron Slates		Jasper + slate		Jasper + slate		Jasper		21 holes 4684 Ft	
	Total	Per foot	Total	Per foot	Total	Per ft	Total	Per ft	Total	Per ft	Total	Per ft	Total	Per ft	Total	Per ft	Total	Per ft
Labor	753 38	707	1344 70	1 040	1187 70	2.483	897 38	1150	125.58	.581	281 00	1615	275 00	1030	705 00	1.720	5569 74	1.189
Fuel at Boiler	99 90	094	349 05	.270	122 50	.256	15 00	019	0 00	.000	37 60	.216	24 00	.090	87 92	.214	735 97	.157
Camp Account.	397 96	.373	723 04	559	376.96	.789	419 37	.538	63 66	.295	108 00	.621	102 50	.384	225 00	.549	2416 49	.516
Bits + repairs on drills	147 93	.139	142 47	.110	140 55	.294	133 54	171	29 25	.135	25 00	.144	27 50	.103	76 00	.185	722 24	.154
Supplies boiler & pump repairs	36 55	034	84 07	.065	18 54	.039	57.52	.074	5 00	023	5 60	032	3 00	.011	16 00	.039	226.28	.048
Carbon	280.11	263	851.40	.658	410 35	.859	671.03	.860	182.01	843	276 29	1.587	249 40	.934	280.50	684	3201 09	684
Superintendence	255 00	239	416 13	322	300 00	.628	31 06	.040	13 49	.063	33 33	.192	37 50	.140	125 00	305	1211 51	.259
Total	$ 1970 83	$ 1849	$ 3910 86	$ 3.024	2556 60	$ 5.348	$ 2224.90	$ 2.852	$ 418 99	$ 1.940	766 82	$ 4 407	718 90	$ 2.692	$ 1515 42.	$ 3 696.	$ 14083 32	$ 3 007

E. J. LONGYEAR, Hibbing, Minn.

TABLE II.

	A		B		C.		D		E		Total	
	2 Holes, 634 Feet		2 Holes 360 Feet		6 Holes 1350 Feet		2 Holes, 611 Feet		6 Holes, 2091 Feet		18 holes 5046 Feet	
	Total	Per ft.	Total	Per ft.	Total	Per ft.	Total	Per foot	Total	Per ft	Total	Per ft.
Labor on drills.	574 33	.905	163 63	.455	1162 86	.862	411 61	.674	1267 84	.606	3550 27	709
Firemen	240 25	379	95 87	.266	457 47	.338	161 97	.265	431 68	206	1387 24	.275
Chopping wood	214 62	.339	150 99	.419	444 92	.329	76 83	.126	378 65	182	1266 01	.251
Camp account	313 70	495	186 94	.519	804 45	.595	393 60	.644	1509 75	.722	3208 44	.636
Bits + repairs on drills	104 66	.165	14 30	.040	117 65	.087	84 90	.138	263 96	.126	585 47	.116
Supplies + repairs on machinery	61 99	.097	7 20	.020	122 06	.092	46 46	.076	202 80	.097	440 51	088
Carbons	465 02	.733	81 56	.227	282 51	.209	337 58	.553	500 00	.239	1660 97	330
Superintendence	109 13	.172	125 00	.347	297 50	220	64 75	.106	410 00	.196	1006 38	.199
Totals and cost per foot	$ 2083 70	$ 3.286	$ 825 49	$ 2.293	$ 3689 42	$ .2.732	$ 1578 00	$ 2.582	$ 4964 68	$ 2.374	$ 13141 29	$ 2.604

J. PARKE CHANNING, at Various Places in Michigan.

"A," was in iron slates, diorite and quartz-porphyry; holes drilled from bottom of 70 ft pit; average advance 5 ft. per shift. "B" in dioritic schist and some jasper; average advance 6 ft. per shift. "C" was a series of fan holes from bottom of 95 ft. pit; mostly hard and broken iron slates; average progress 5 ft. per shift. "D" was of two holes from a shanty with stand pipe 17 and 20 feet respectively; ten shifts on the stand pipes. 44 on the drilling; actual progress in the rock 14 ft. per shift; material, hornblende schist, jasper and quartzite. "E" was a series of fan holes from the bottom of a wet pit: material quartzite; rate of progress at beginning each hole 18 to 20 feet per shift; average rate 8 feet

TABLE III.—EAST NEW YORK MINE, ISHPEMING, MICH.

			Total cost.	Per ft
Labor	400¼ days setter @ $3..........	1200.75	2506.10	.669
	372 " runner @ 2.25........	837.00		
	230¼ " " @ 2.00........	460.50		
	4½ " laborer @ 1.75........	7.85		
Carbon 68⅜ karets @ $15.144....................			1035.47	.276
Bits, lifters, shells and barrels and rprs....................			433.81	.115
Oil, candles, waste, and supplies....................			128.09	.035
Estimated cost compressed air....................			374.60	.100
Total....................			$4478.07	$1.195

Number holes drilled....................	28	
Drilled in hematite	193	feet.
" " jasper....................	646	"
" " mixed ore....................	986	"
" " dioritic schist....................	1921	"
Total drilling....................	3746	"

No. of ten hour shifts drill was running including moving and setting up.	603	feet.
Amount drilling per 10 hour shift....................	6.2	"

TABLE IV. MINNESOTA IRON COMPANY. TWENTY MONTHS FROM MAY 1, 1894 TO DEC. 31, 1895.

MINES.	Feet drilled.	Carbon.	Cost per foot.	Supplies and oils.	Cost per foot.	Fuel.	Cost per foot.	Shop labor and material.	Cost per foot.	Pay roll.	Cost per foot.	Total cost.	Cost per foot.
No. 1 Mine	697.11	456.07	.653	153.63	.220	27.92	.040	64.75	.093	308.68	.442	1011.05	1.448
No. 5 Mine	62.5	21.80	.349	9.05	.145	5.52	.088	15.	.240	22.75	.364	74.12	1.186
No. 7 Mine	422.	306.90	.727	26.76	.063	16.88	.040	4.20	.010	133.74	.317	488.48	1.157
No. 8 Mine	12329.9	3803.05	.308	750.40	.061	497.07	.040	595.06	.048	3229.66	.262	8875.24	.719
	13512.1	4587.82	.340	939.84	.070	547.39	.040	679.01	.050	3694.83	.273	10448.89	.773

NOTE.—This drilling was all done in the back stopes, almost every foot being in the ore. The drills used were the Sullivan make, "E" size, the holes being 1½" in diameter, and from 10 to 40 ft. deep, the machines being operated by compressed air.

TABLE V.—CLEVELAND MINE, ISHPEMING, MICHIGAN, 1892.

Underground drilling.....	6075	feet.
Surface "	1414	"
Standpipe sunk..........	470	"
Total distance run ..	7959	"
Actual drilling time undg.	672	shifts.
" " " on surf.	165	"
Time of foreman, setter, moving, and standpiping	1314	"
Total time worked .	2151	"

Av. progress per man per shift	3.70	feet
" " " drill " " actually running.....	8.95	"
Weight of carbon consumed	111.	karets.
Dist. drilled per kt. of carbon consumed.........	67.38	feet.

	Amount.	Per foot
Cost of carbon.........	1887.	.237
" " supplies and oils	134.13	.017
" " fuel...........	360.73	.045
" " shop material, etc.	663.36	083
Pay roll...	4000 03	.502
Total cost	$7045.25	$.884

PRACTICAL ASSAYING AT MINES AND WORKS.

By H. Van F. Furman.

IN the past ten or twelve years a great advance has been made in the United States in the art of assaying and technical chemical analysis. The assayer or chemist of a decade since would be utterly unable "to hold up his end of the line" in a modern metallurgical works. While rapidity and the ability to execute a large amount of work in a given time have been the points which have seen the greatest development, accuracy has not been overlooked. There has probably never been a period in the history of the business when margins were so small and competition was so great, and hence when greater accuracy was required. In the early days of smelting in the United States the margins on ores purchased were generally large. In those days the shipper did not exercise the same care to check the returns made by the purchaser as at present. Frequently there was no competition, and the seller was compelled to accept what the purchaser would give for a lot. Under the fierce competition and improved methods of the present day all this has been changed.

While it is true that a majority of our best assayers and chemists received their preliminary training in a technical school, the courses of instruction in these schools have hardly kept up with practical progress and the requirements of the times. A graduate of one of our technical schools who obtains a position at a modern works will first have to forget a great deal of that which he has been taught. This lesson having been learned, and habits of precision having been acquired, he will probably become an excellent workman. Should the student in the laboratory of one of our schools be presented with some thirty or forty samples of ore in the morning with the request that the gold and silver contents of each be accurately determined,—the report to be made the same afternoon,—he would probably regard the task as impossible. Should the task be undertaken, he would probably become so hopelessly mixed and nervous that his results would have but little value. Such, however, is not an unusual day's work in a modern establishment, and at many mines from one hundred to one hundred and fifty determinations of gold and silver are frequently required in the course of a day. Thirty control samples for gold and silver, each sample requiring at least duplicate determinations of both the gold and silver, are often received in a modern metallurgical works. Seventy-five determinations in the analytical laboratory will not be considered unusual for a modern chemist.

The young graduate, upon assuming a position at a mine or reduction works, will have straightway to acquire system, rapidity, and accuracy. The first is absolutely essential, and, until a proper system is adopted and carefully carried out, good results can not be expected. Herein lies a dividing line between the school and shop-work. In the school the student will be given two or three samples, and ample time to obtain his results; in the shop the operator will be given a large number of samples, and required to furnish the results in a limited time. This can be accomplished only by having the work so systematically arranged that a large number of determinations can be carried out simultaneously. In a well-conducted office twenty-five to thirty-five fusions or scorifications will be carried out together. In the same manner a large number of cupellations—from fifty to seventy-five—are usually run simultaneously. In this way the different determinations are carried through the separate steps in series, thus saving a great deal of time and labor.

Rapidity is frequently of the utmost importance. At a mine the miners and ore sorters will frequently have to wait for the assayer's results before proceeding with their work. At a metallurgical works the working of the plant and the quality of the product will often be largely dependent upon the result of an analysis, which must be rapidly performed to be of value.

Accuracy within narrow limits is absolutely essential. When it is considered that over $100,000 may be paid out for ore, etc., as the result of one day's assays at a modern plant, the importance of accuracy becomes apparent. The results obtained in commercial gold and silver assaying, while not scientifically accurate, are probably much nearer the truth than those obtained by any other commercial industry. There is a mistaken idea in the mind of the uninitiated that the fire assay for gold and silver invariably yields results far below the actual contents. This idea is not without foundation, as there must be a loss of precious metals under fire processes. However, in a series of experiments recently conducted by the writer to demonstrate that which had frequently been demonstrated,—that these losses were not as great as generally supposed,—the loss of silver in the scorification assay was found to be 2.54 per cent., and the loss in the crucible assay was found to be 2.58 per cent. The loss of gold was nominal (scorification 0.8 per cent., and crucible 0.3 per cent.). In another series of experiments on the assay of base (lead) bullion the silver loss was found to be 1.55 per cent., while the gold loss was trifling. In the fire assay of silver bullion a great number of experiments show the average loss to be about 1 per cent. However, when silver bullion is assayed by the fire method, the losses are always corrected by running a proof assay with each set of determinations. The average loss of gold in the assay of gold bullion is about one part in one thousand, or 0.1 per cent. This loss is invariably allowed for, and corrected, by running a proof assay with each set of bullion assays. As the losses in ore assaying are well known, and allowed for in the purchase of ores by our modern works, they can not be considered as of serious moment.

The limits of accuracy to be attained will depend largely upon the character of the work. Mine samples do not require as much care as control samples upon which the ore is sold. One determination for gold or silver on each mine sample is usually all that is required. The assayer at a reduction works will frequently receive samples in handling which speed is of more importance than extreme accuracy. As to the allowable limits of variation on control samples, it may be considered as 0.5 ounce silver and 0.1 ounce gold on ores assaying up to 100 ounces silver and 3 ounces gold per ton. However, no exact rule can be given as to the allowable variation. Many samples of high-grade ore will be encountered with which the only safe rule, on account of the variations in individual assays which may be expected, is to run a large number of assays and then average the results. The modern assayer must be a man of judgment as well as of skill.

The sampling of ores and metallurgical products, while not properly coming within the scope of the assayer's work, is a subject which should be thoroughly familiar to the practical assayer. Unless the samples truly represent the mass or lot from which they were taken, the subsequent assays will be valueless. The assayer at a mine or works generally receives the samples already prepared, but there are occasions when he is called upon to take his own sample. Hence the art of sampling should be thoroughly understood by the assayer. As it is not within the scope of this article to take up the subject of sampling, we will begin with the point at which the sample is delivered to the assayer.

The ore sample is usually delivered to the assay office in a sealed bottle, or paper sack, with the assay number plainly marked upon it. The works generally make three samples; one to be delivered to the shipper, one to the works assayer, and one to be held in reserve for delivery to an independent assayer, as umpire, in case of a disagreement between the works and the shipper. Each of these samples has been carefully and indiscriminately cut out of the general sample of the lot, and passed through an 80- or 100-mesh (the latter is now the Colorado practice on gold ores) sieve.

The assayer, on commencing work in the morning, usually has a number of samples on hand. Each sample is taken up by itself, spread upon a piece of rubber cloth, and thoroughly mixed by means of a steel spatula, the pile being finally spread out into a flat layer of about one-eighth inch in thickness. From this layer the assay samples are taken with a small steel spatula, going over the layer and taking a portion on the point of a knife from each part. Care should be exercised here to always dip the knife down to the bottom of the layer, so that each portion will represent the layer from top to bottom. The portion usually taken in Colorado for each gold assay is $\frac{1}{2}$ assay ton.[*] This is introduced into a 20-gram crucible, together with the proper fluxes, which consist of litharge, sodium bicarbonate, borax glass, a reducing agent (as flour or argols), or an oxidizing agent (as nitre), according to the requirements, and such other fluxes as may be necessary. The necessary fluxes have to be added according to the mineralogical composition of the ore. It is largely here that the assayer's skill and experience enable him to obtain correct results. According to the method taught in many technical schools, when the assayer is in doubt as to the proper charge, he should run a preliminary assay. The practical assayer has no time for preliminary assays, but must judge the character of the ore simply by eye-inspection; when in doubt, the writer has found that, by placing about half a gram of the ore on a watch glass and vanning with a little water to separate the lighter and heavier minerals, and then by inspection judging as to the minerals present and their approximate amounts, the character of the sample could be determined sufficiently for assay purposes, and with a small expenditure of time. According to the Colorado practice, most gold assays are run by the crucible method, and most silver assays by the scorification method. It is hardly within the scope of this article to discuss the reasons for the adoption of these methods, but it is sufficient to say that they appear to give the best results.

After weighing out the gold charges, the silver assays are weighed out, $\frac{1}{10}$ assay ton being the general charge. On control samples three or more charges will be weighed out and introduced into a scorifier, together with the proper amount of pure granulated test lead, half of which is mixed with the ore and half of which is added as a cover to the charge. In addition, a little borax glass, and occasionally other fluxes, are added to the charge. In this manner the assayer proceeds with each sample, a convenient system being that adopted by the writer as follows: the assay number of the first sample weighed out is entered in the assayer's memorandum-book at the top of the page for the day. This becomes Number 1, and, should a duplicate be run, the assay number will appear twice, the duplicate becoming Number 2 of the day's work. In this manner the weighing out is proceeded with, the charges being arranged somewhat as follows:

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[*] The Assay-Ton System of Weights was devised by Prof. Chas. F. Chandler of Columbia College. As there are 29,166.6 troy ounces in one ton avoirdupois (2,000 pounds), the assay ton contains 29.166.6 grams; hence, if one assay ton of ore is taken for assay, and the resulting button weighs 10 milligrams, the assay value of the ore will be 10 ounces per ton One ounce per ton is 0.00343 per cent.

1, 2, 3, 4,
5, 6, 7, 8,
9, 10, 11, 12, etc.

According to this system, we always begin at the upper left hand and read exactly as a page of a book is read. Provided the same relative order is always retained, it is immaterial how many charges are introduced into the furnace at a time; they cannot be interchanged, and any charge can at any time be picked out and separated from the others, if necessary.

When a sufficient number of charges are prepared, they are introduced into the furnace for fusion or scorification. When the fusion or scorification is finished, the charges are removed from the furnace and poured into conical iron moulds, the same relative order being retained. As soon as the slags and buttons have cooled, which generally requires about fifteen minutes, the lead buttons are removed from the slag and pounded on the anvil into cubes. Each cube of lead is now introduced into a hot cupel in the muffle furnace, and the door is closed until all begin to cupel, when it is opened, and cupellation is continued until the buttons brighten, thus showing the elimination of the base metals.

As has been remarked, the Colorado practice is to run the gold assays by the crucible method, the fusions being performed in the muffle furnace, and the silver assays by the scorification process. When this method is adopted, it is customary to add a small piece of pure silver to the gold crucible assays, in order to insure the parting of the button. The gold-silver beads, resulting from the gold assays, are flattened by a few blows of a hammer on a steel anvil, and are then parted for their gold contents. The method of parting generally adopted consists in introducing the flattened button into a small porcelain crucible, adding dilute nitric acid, and heating until action of the acid apparently ceases. The solution of silver nitrate is poured off, strong nitric acid is added, and the buttons are boiled for four minutes. This solution is then decanted off, and the gold is washed twice with distilled water, and, after drying and annealing, is weighed. The balance used for this purpose will weigh to at least 0.01 milligram, and should be used only for this purpose. The silver-gold buttons resulting from the scorification assay are removed from the cupel, brushed with a stiff bristle brush to remove adhering particles of bone-ash, etc., and weighed, the gold as obtained in the crucible assay being deducted, and the difference being the silver assay of the ore.

Such, briefly, is the work required of the assayer, although, if employed at a smelting and refining establishment, he will be required, in addition to the ore assays, to make assays of base bullion, mattes, slags, doré bullion, silver and gold bullion, by-products, etc. Each of these assays requires special methods, which it is unnecessary to discuss further than to say that the same accuracy and care are essential throughout.

The form of report to be handed in by the assayer will depend largely upon the system adopted by the works. An admirable system adopted by one of our prominent reduction works is this : the samples delivered to the assayer are marked simply with the assay number of the lot, and each afternoon the assayer fills out his report containing the assay, or works lot number, together with the results on each number. Under this system the assayer does not know, nor has he any interest in, one sample above another. This system also enables the management to check the assay returns at all times and without the knowledge of the assayer. At another establishment, where a number of men are employed in the assay office and laboratory, a different system is adopted. Here all samples are delivered to a head assayer, who examines each, marks it with the constituents to be determined, and remarks as to the general character of the sample. The samples are then turned over to the assayers for the proper determinations.

REVIEW of THE ENGINEERING PRESS

WITH A DESCRIPTIVE INDEX TO THE LEADNIG ARTICLES PUBLISHED CURRENTLY IN THE AMERICAN AND ENGLISH ENGINEERING AND ARCHITECTURAL JOURNALS.

INTRODUCTORY

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles o the month which are deemed of most importance ; (2) to supply a descriptive Index to the leading articles published currently in the engineering, architectural and scientific press of the United States, Great Britain and the British Colonies; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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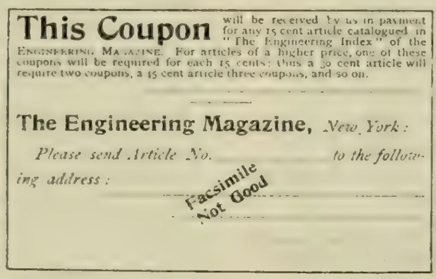

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American Gas Light Journal. *w*. $3. New York.
American Geologist. *m*. $3.50. Minneapolis.
American Journal of Science. *m*. $6. New Haven.
American Journal of Sociology. *b-m*. $2 Chicago.
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American Magazine of Civics. *m*. $3. New York.
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American Miller. *m*. $2. Chicago.
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Annals of Am. Academy of Political and Social Science. *b-m*. $6. Philadelphia.
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Architect, The. *w*. 26*s*. London.
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Brick Builder, The *m*. $2.50. Boston.
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Bulletin of the Univ. of Wisconsin, Madison.
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Canadian Architect. *m*. $2. Toronto.
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Journal Political Economy. *q.* $3. Chicago.
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Western Railway Club, Pro. Chicago.
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ARCHITECTURE & BUILDING

See also "Civil Engineering" and "Domestic Engineering."

The Boston Public Library.

SCRIBNER'S MAGAZINE for January contained an article by Mr. T. R. Sullivan on the new Boston Public Library building, —one of those descriptive articles that pass current for architectural criticism, and yet accomplish very little in the diffusion of architectural knowledge. The pictures which accompany the text are good.

The Boston Public Library building is easily one of the most notable public structures in America. It is a noble addition to any city group, and its situation on Copley square, while adding somewhat to the variety of edifices that surround that spot, is perhaps as good a site as could have been found for it. The real architectural importance of this building to the public is that it is a great municipal undertaking, planned for strictly utilitarian uses, to which has been given an artistic and beautiful form, making it as fine a building as has been produced in America. It is not possible, in the space of a few paragraphs, to summarize the ar qualities of this structure. It is monumental and stately, refined and imposing. True, the main façade is a free following after the façade of the Bibliothèque St Geneviève at Paris; but the copying has not been slavish or accurate. On the contrary, the original design has been made the basis of the present one, and enlarged and bettered, until the Boston building may rightly be taken as a true and direct suceessor to the Paris building. This view is not that generally taken by the architects who did not have the opportunity to build this structure; but such must be the view of every one who fairly compares the two.

The monumental quality that dominates the façade is a leading element throughout the building. Its plan—an open court in the center surrounded on all sides by the library building—is perhaps wanting in that compactness which is necessary to economical planning in libraries, but a certain monumental effect has been maintained throughout all the public rooms, while the inner parts—the stacks and smaller rooms for readers and students—appear, save in some cases where the light is not quite ample, to be entirely sufficient for their purpose.

There is a monumental vestibule and stairway, the latter rich in costly marble, but injured by the narrowing of the stair arch, yet having a splendor of its own that is entirely appropriate to its purpose. The painted decorations which are to surround the upper walls are not yet all in place, but the green and blue pictures on the main wall are certainly destined to lead to much discussion among the uneducated, whose first glimpse of modern art —truly modern art, that is—will be derived from contemplating them. Bates Hall is unquestionably a splendid apartment, though a good deal of the effect of its proportions is lost, because it is usually entered at the center of the side, where the perspective of the arches is quite without value and the great size of the apartment not fully realized. The stairway leading to the upper hall, which Mr. Sargeant has partly decorated, is by no means in keeping with the corridor to which it leads, and the corridor itself is scarcely well proportioned or happily placed. Still, there are in these rooms many positive results of genuine artistic value that quite justify any eulogy. The building is supplied with many mechanical devices that add to its efficiency, but with which the architectural critic seldom busies himself. They should not, however, be neglected in any study of the building.

John Stewardson on American Architecture.

THERE is a melancholy interest in the paper on "Architecture in America: A Forecast," contributed by John Stewardson to *Lippincott's Magazine* for January;

for on the sixth day of that month its accomplished author was drowned, and one of the most active and useful lives in American architecture brought to a sudden end. It was perhaps not the least of Mr. Stewardson's advantages that he should have been brought up in Philadelphia and have entered into practice there. In no other city was the architectural spirit less developed, and in no other place, it might with truth be said, were such eccentric designs accepted as the best of architecture. The architectural state of his city at the time of Stewardson's death was very different. One of a little band of architects who labored for the art in its highest sense, he was one of the most earnest supporters of that movement which has wrought a change in Philadelphia's buildings, and made many of her structures real works of art, which, in a few instances, are worth going many miles to see.

Mr. Stewardson was an ardent adherent of the French faith which is now having full swing in the United States. His article in *Lippincott's* was written to point out what he conceived to be our architectural salvation through that faith. One does not need to agree with its writer to admit the earnestness of his argument or the value of his own work. This, fortunately enough, was far from illustrating the faith in foreign ideas which Mr. Stewardson himself felt. And his article is characterized by the same liberal spirit. It is a notable thing to find in a man bred in the Beaux-Arts the admission that the treatment of business buildings in France is monotonous, and that their interest ceases with their plans and their proportions. It is refreshing to find one so trained confessing that the detail of these buildings is, as a rule, crude and unfeeling. It is to be hoped that Mr. Stewardson's associates will practise the same system of truth-telling that he has done in this article. There can be no dispute as to the facts; yet how many of the members of the Beaux Arts Society of Architects, New York, are so frank?

On the contrary, it is the general tendency of these gentlemen to insist on the general perfection of the French style in every particular, and to set forth these perfections as their own basis for following it. Fortunately Mr. Stewardson practised what he preached. None of his more important buildings exhibited that formalism which we are rapidly coming to associate with classicism, and which is identical with it in France. On the contrary his designs were well studied and original, with a final effect of great interest, and quite devoid of those eccentricities of mannerism—if they may be so styled—in which his *confrères* delight.

The death of Mr. Stewardson is a distinct loss to Philadelphia, and a loss to the cause of good architecture in America. The hope for the future cannot, indeed, be in that cold classicism for which France is famous, but in a rational treatment of all problems in themselves; and with the truth of this statement Mr. Stewardson would himself, probably, have been the first to agree.

Herbert Spencer on the Origin of Architects.

THAN Mr. Herbert Spencer there is no more weighty philosopher living; yet his most ardent admirer must admit that the chapter on architects in the series on "Professional Institutions" which he is contributing to the *Contemporary Review* is one of the slightest pieces of work he has done, and, in fact, as valueless a contribution to architectural literature as has been made by any writer within the past decade. Mr. Spencer's object is to trace the origin of the architect, and he begins his task without any consideration of the origin and nature of architecture, and by only the briefest reference to the primitive man's knowledge of the art of building. He then proceeds to remark that "we are at once met by the broad fact that the earliest architecture bequeathed by ancient nations was an outcome of ancestor-worship." In itself this may be true enough, but it entirely ignores the earlier fact that man certainly built structures for shelter before the buildings for worship which he bequeathed to those who came after him.

The inference of the philosopher, who continues his work with a most philosophic disregard of definitions and positions, is that the first architects were priests, though not a hint is given of what architects are. The priestly origin of architects is supported by quotations from various writers, whose competency here is not always evident. Mr. Spencer concludes his essay in this manner:

"Chiefly for form's sake reference must be made to the gathering together and consolidation which, in our times, has been set up in the architect's profession. There is little to remark further than that, the members of it having been but a few during earlier periods, when the amount of architectural building was relatively small, segregation and association of them could scarcely occur. Recently, however, there has been formed an Institute of Architects, and the body of men devoted to the art is tending more and more to make itself definite by imposing tests of qualification.

"At the same time cultivation of the art and maintenance of the interests of those pursuing it are achieved by sundry special periodicals."

FRENSHAM HALL, HASLEMERE.—Messrs Beazley & Burrows, Architects

Had Mr. Spencer undertaken the study of architects with that breadth of view and penetration of thought to which he has accustomed the readers of his philosophical dissertations, he would have found a singular confirmation of his religious theory in certain architectural tendencies of the present day. Apparently, however, the fame of that noble American band, the Frenchites, has not yet extended to those sources from which he derives his architectural information. Yet the doings of these people here in America would clearly have strengthened the theory put forth. They are a consecrated body of men, with a peculiar quality of their own that at once stamps them as a species of high-priests of their art. The development of such a coterie at this late day, so remote from the origin of architects, could not, had it been known to Mr. Spencer, have failed to impress him as a most singular and interesting survival at a most unexpected time and in a most unexpected quarter. It is hard to believe, moreover, that this company of Chosen Ones would not have materially strengthened the philosopher in his views.

Some Recent Church Designs.

DURING the past few months the *Amer-*

ican Architect has been printing a series of papers entitled "Art in the Modern Church," by Mr. Barr Ferree. It was, perhaps, not necessary to compose a treatise to demonstrate that the general standard of church architecture in America is very low; but it may have been of some value to point out that a church is, by its nature, a very different sort of building from a hotel, a house, a commercial building, or any other structure. In other words, we have in the present day almost forgotten the fact that the church has a meaning and purpose quite distinct from that of other buildings. It was to point out this thesis, and support it by copious reference to contemporary buildings, that the series in question was prepared.

Some recent designs of churches published in the architectural journals show that no definite progress is being made in this form of architecture, which has certainly not been as much improved within the last ten years as commercial architecture, or perhaps as much as house architecture. Of course, we live in a commercial age, in which everything save the ornamental receives close attention. Churches cannot well be dispensed with, but their nature is not as utilitarian as the larger number of modern types of building. Compare, for example, the design for the new cathedral at Berlin (*American Architect*, Jan. 18) with a design for a new cathedral at Washington (*Harper's Weekly*, January 25). In both cases the idea of the architect was to devise a monumental structure, and to work on this basis to the extent of his individual capacity or the intelligence of those employed by him. In neither case has any effort been made to prepare a design which should have, first of all, a religious quality, or a distinctive character unmistakably Christian. We recognize these buildings as churches, not because they are of a Christian type of architecture, but because, by the process of exclusion, we see they cannot possibly be anything else!

The design for a Town Church (*Builder*, January 11) by a student at the Royal Academy is, of course, only a bit of student work; yet it illustrates, in a measure, the prevailing conceptions of church architecture. In this instance they are found to be a certain eccentricity of design, a persistent employment of the vault and dome, and a hardness and ugliness of parts that are neither pleasing or religious. Sir A. W. Blomfield's restoration of St. Peter's, Eaton square, London, is scarcely better than any of these, so far as the architectural parts are concerned, though a certain ecclesiastical effect is obtained by the furnishings and decorations. Saviour's Priory Chapel, Haggerstone, England (*Builder*, Jan. 18), is hardly likely, in construction, to be as effective as the drawing printed in *The Builder*.

More interesting than any of these is the design for St. Andrew's church, Bacsom Bascombe, England (*Builder*, Jan. 4), —a truly poetic design, full of intense artistic feeling, revealing a deep personal interest and characterized by a purposeful quality which we instinctively recognize as distinct and individual.

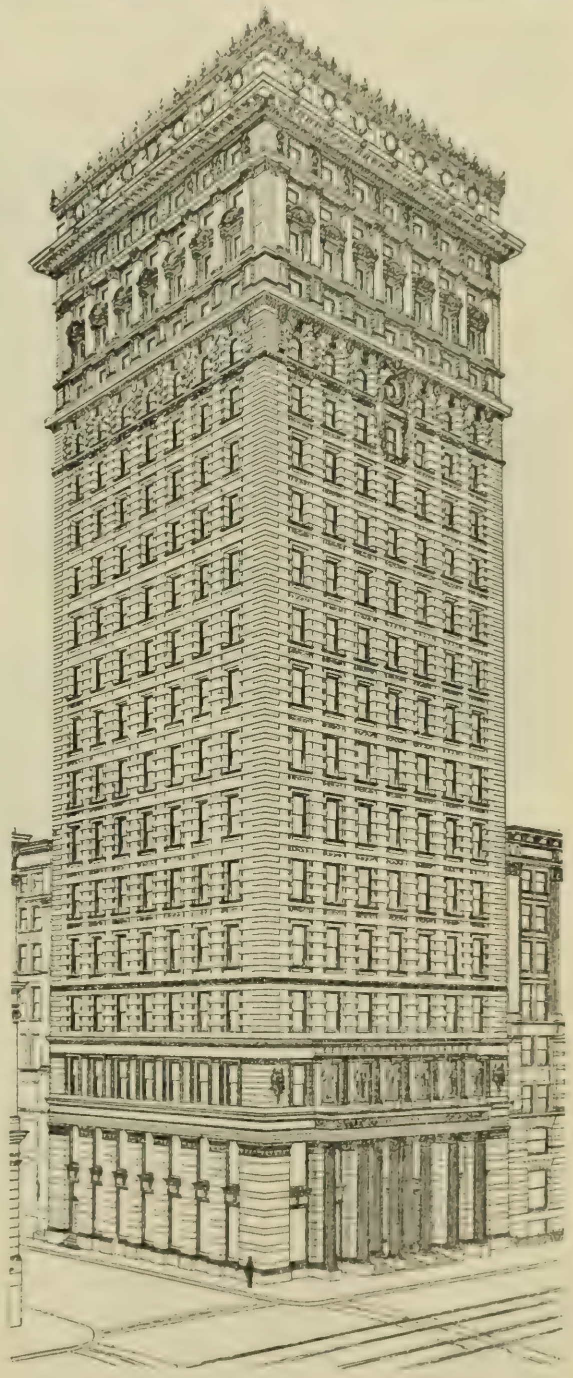
The designing of churches is really a consecrated task, which should be approached in a very different spirit from that with which one begins an ordinary piece of work. The church building must be studied for its religious effect rather than for its esthetic value.

The Paris Exposition for 1900.

THE AMERICAN ARCHITECT says that the Paris Exposition of 1900 is developing under difficulties. In particular it is meeting with opposition in the Chamber of Deputies. The last proceeding of this body in this direction is to forbid the use of any part of the Champs Elysées for the exhibition, to interdict the removal or rebuilding of the Palais de l'Industrie, and to direct that all the exhibition buildings shall be confined to the left bank of the Seine. This decree upsets completely the fine plans for a monumental bridge, extending from one grand cluster of palaces on the right bank, to another on the left, and restricts the exhibition within a smaller space than was occupied by that of 1889. The Municipal Council of Paris is also disaffected.

Illustrations of the Month.

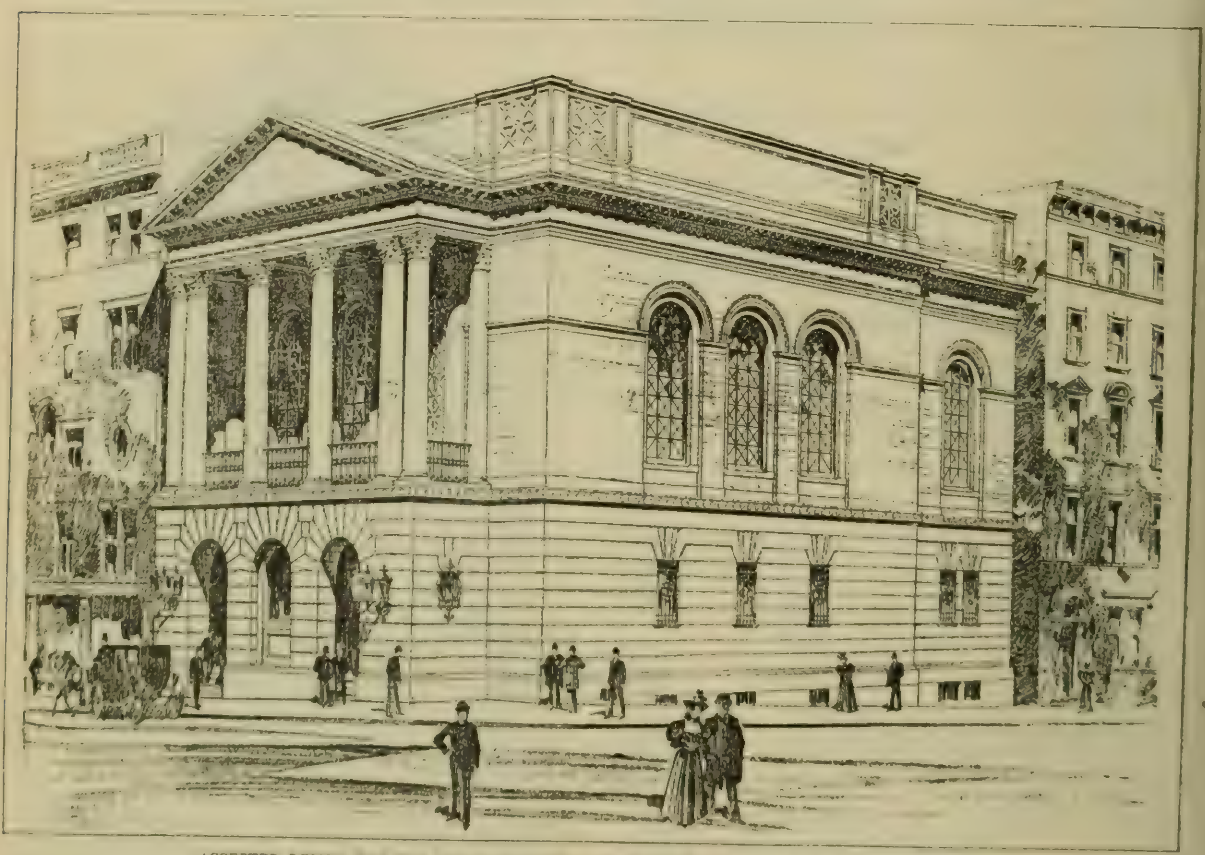
Architecture and Building publishes (January 11) a beautiful photograph of the fine house for Mrs. Josephine Schmid on Fifth avenue in New York, by Richard Howland Hunt. It is in the château style in which the architect's father achieved his most notable successes, and a work of genuine interest. It may be questioned, however, if the very effective high-sloping roof does not entail some unnecessary loss of space in the upper floors. The same journal also publishes (January 4) a line



AMERICAN SURETY BUILDING.

drawing of the American Surety Building in New York, a structure which has some distinction bv reason of its small base of about eighty-five feet and its very great height of twenty-one stories. The entrance, with its porch of Ionic columns, doubled in the centre, and its six statues above, is immensely successful, and, when completed, will unquestionably be one of the finest ornaments to Broadway.

The photogravure plates of the *Inland Architect* (January) reproduce a number of interesting buildings, chiefly residences in Chicago. Of seven houses shown five are provided with classic or Renaissance columns, and other features which now appear to be regarded as essential to "modern" design, thereby certainly increasing the use of fine stones and marbles, though indicative of a rather singular form of procedure, since architectural effect should consist in more than a setting up of two or more columns before a doorway or for supporting a porch. Several of the plates of this number are quite unneccessarily given up to illustrating a competition instituted by the Chicago Architectural Club. No literary journal would think of publishing the compositions of college students; why, then, should the experimental work of architectural students be perpetuated in published form ?

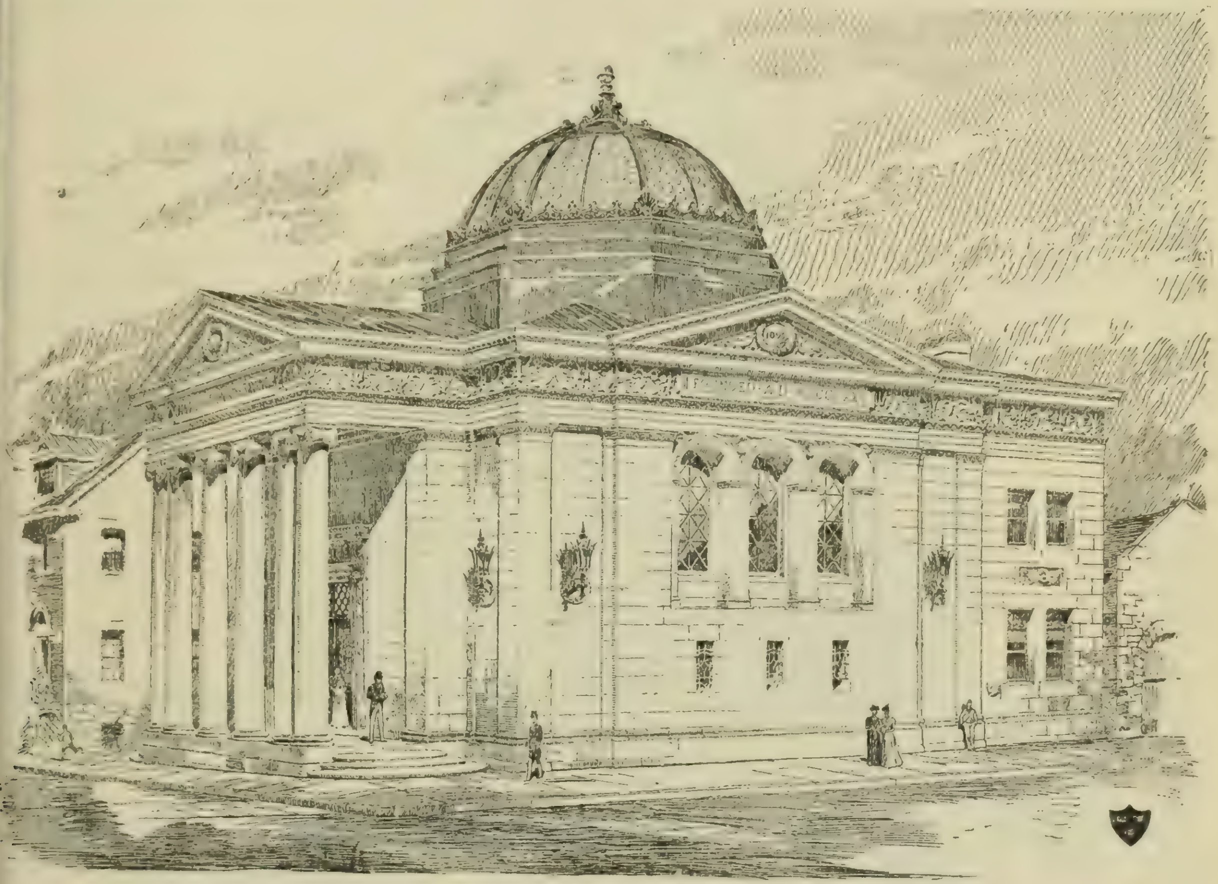


ACCEPTED DESIGN FOR THE NEW BEDFORD SAVINGS BANK BUILDING, NEW BEDFORD, MASS

CHARLES BRIGHAM, ARCHITECT

The *American Architect* publishes some superb photographs of the interior of the Metropolitan Club House in New York, technically the most beautiful illustrations of the month. It prints, also, two interesting photographs of the Johnston Emergency Hospital at Milwaukee. In the same number (January 25) it reproduces three competitive plans for a new savings bank at New Bedford, by Peabody & Stearns, Andrews, Jaques & Rantoul, and Charles Brigham, whose design was selected. Why architects of the standing of these firms should have been asked to compete for so small a piece of work as this is not clear; certainly a satisfactory design might have been expected of either of them. The accepted design presents an exterior in two stories, with a classic portico above on the main front.

Within, the building is found to be but one story high, the portico being at the level of an inner gallery, and thus emphasizing a secondary feature. The design by Messrs. Andrews, Jaques & Rantoul is much more logical. The portico is on a level with the street, and the building seems to be—what it really is—a single-story structure. The design submitted by Messrs. Peabody and Stearns is, properly enough, a single-story building, but so closely modeled on the paper designs of French architects as to seem almost like a reproduction from the *Croquis d'Architecture*.

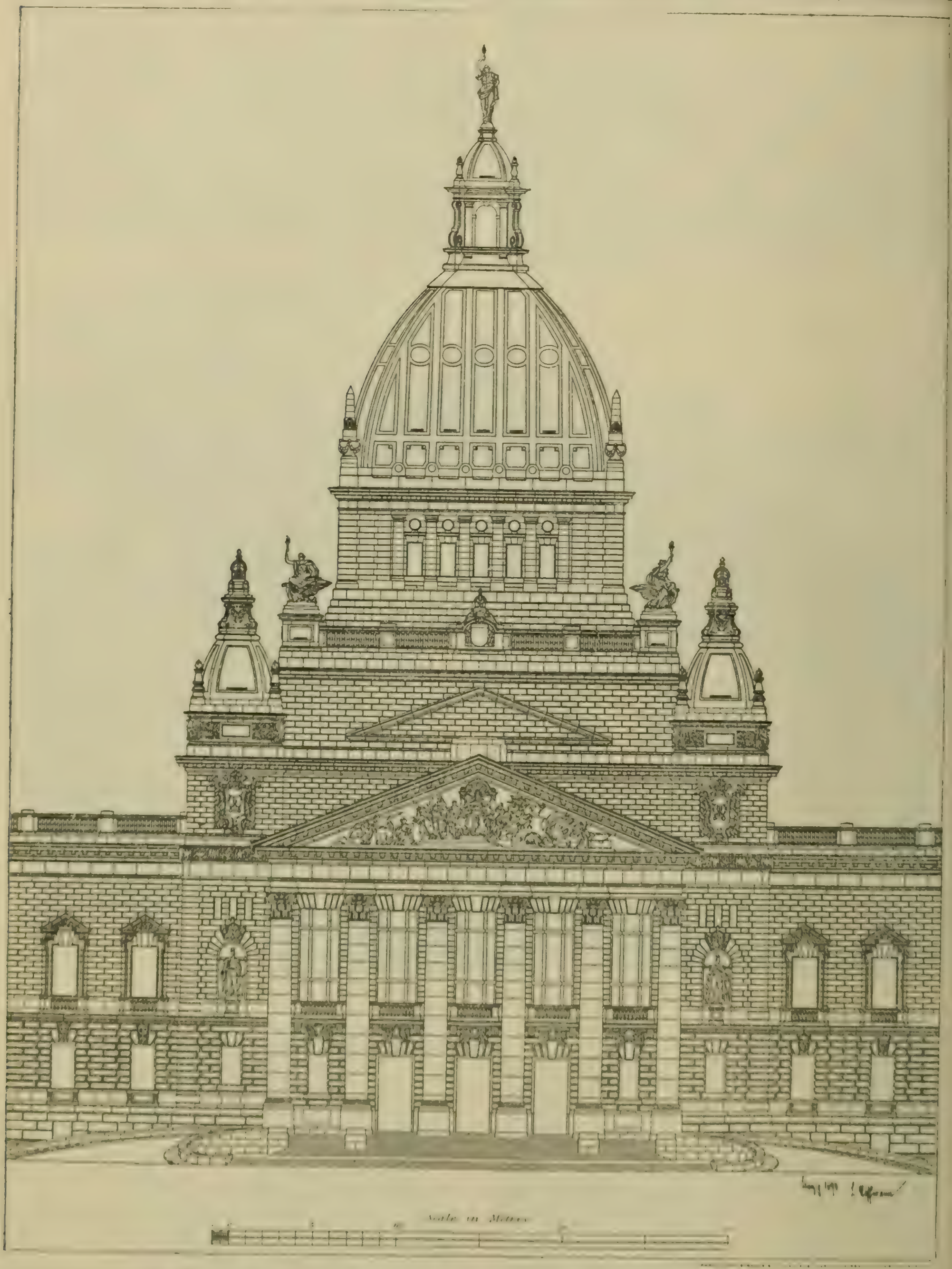


COMPETITIVE DESIGN FOR THE NEW BEDFORD SAVINGS BANK BUILDING, NEW BEDFORD, MASS.
ANDREWS, JAQUES & RANTOUL, ARCHITECTS

A melancholy interest attaches to the photographs of the interiors of the superb house of Lord Leighton, reproduced in several numbers of *The Architect*. Lord Leighton's interest in architecture was that of a friendly and interested critic, and the honors bestowed upon him by the Royal Institute of British Architects, which gave him the Royal Gold Medal and an Honorary Fellowship, testify to the loving regard and estimation in which he was eld by his countrymen. By long odds the most conspicuous figure in contemporary English art, Lord Leighton's death leaves a void in the art and social world of England that will not be speedily filled.

The *Architectural Record* interrupts its series of "Architectural Aberrations" to find space for praise of Mr. Hardenbergh's beautiful Wolfe Building in New York, a finely picturesque structure, whose genuine beauty is the more remarkable because of its strictly commercial and utilitarian nature. It is, however, somewhat of a shock to read in our contemporary that one of the merits of this building is a grace that a painter might like to paint! There could hardly be a greater misconception of the nature of commercial architecture than a statement like this. It is doubtless an agreeable thing to have a paintable building, so far as looks go or esthetic enjoyment; but to set this down as one of the notable and important characteristics of a commercial building—as one of the reasons, to speak plainly, for admiring it—is certainly to confess the densest ignorance of the subject.

IT is the custom of some of the British architectural journals to make their New Year's number a special issue, with many extra illustrations. This year *The Builder* leads in the number and importance of its pictures, its issue for January 4 being an especially rich and valuable one. Among English buildings it publishes a photograph of the New National Portrait Gallery in London; a study for the west front of the proposed church of St. Andrew, Boscombe (in colors), by Mr. H. Wilson; a view and plan of Kirkstall Abbey in its series of the Abbeys of Great Britain; a four-page



THE IMPERIAL LAW COURTS, LEIPSIC. ELEVATION OF CENTRE OF PRINCIPAL FRONT. HERR LUDWIG HOFFMANN, ARCHITECT.

drawing, "Under the West Front Arches of Peterborough Cathedral," by Mr. G. C. Horsley, a striking picture from a novel point of view; and a view of Ludgate, London, in the time of Henry VIII,—one of Mr. H. W. Brewer's imaginative and interesting restorations. Italy is represented by a front elevation of the new Vittorio Emanuele theater at Palermo, by Mr. G. B. F. Basile; Germany by a view, plans, and part of the front elevation of the Imperial Law Courts at Leipsic, by Mr. L. Hoffmann; and France by a photograph of the monument to Meissonier in the "Jardin de *l'Infante*" of the Louvre, by Mr. Mercié, and one of the painted ceiling, "L'Apothéose des Lettres," in the Salon des Lettres in the Hotel de Ville at Paris, by M. Jules Lefebre. In a subsequent issue *The Builder* gives three drawings of a design for a Town Church which won for Mr. P. Rodeck the Royal Academy Gold Medal and Travelling Studentship for 1895, —a design we hope never to see built.

THE ENGINEERING INDEX—1896.

Current Illustrations and Leading Articles on Architecture and Building in the American and English Architectural and Engineering Journals—See Introductory.

Index to Illustrations.

Apartment Houses.—For C. E. Rector, by J. M. Van Osdel, In. Archt., Jan.—Entrance, 105th st., New York, by R. S. Townsend, Archt. and Build., Jan. 25.

Armory.—Jersey City, N. J., by C. A. Gifford, Archt. & Build., Jan. 18.

Churches.—Trinity Evangelical Lutheran(with plan), Johnstown, Pa., by J, A. Dempwolf, Amer. Archt., Jan. 11.—New Cathedral, Berlin, Prussia, by Prof. Ruschdorf, ibid., Jan. 18.—Proposed, of St. Andrews, Bascombe, Eng., by H. Wilson, Builder, Jan 4.—At Hagerstone, Eng. (with plan and interior), by C. H. M. Mileham, Ibid., Jan. 18.—St. Peter's, London, Eng. (3), restored by Sir A. W. Blomfield, Archt., Jan. 3, 10, 17.—Church of the Immaculate Conception, Yonkers, N. Y., L. J. O'Conner, Archt. and Build., Jan. 25.

Club Houses.—Golf and Country Club, Ridgefield, Ct., by W. A. Bates, Amer. Archt., Jan. 4.—Metropolitan Club, New York (3 interiors of south lounging room), by McKim, Meade and White, ibid., Jan 11.—Hall of Mercers Company (staircase), London, Eng., ibid,, Jan. 18.—Calumet Club, Manchester, N. H. (with interior), by W. M. Butterfield, In. Archt., Jan.

Commercial Buildings.—Savings Bank, Cedar Rapids, Ia., by Josselyn and Taylor, Amer. Archt., Jan. 11.—Linder's Real Estate Co., St. Louis, Mo., by Shepley. Rutan and Coolidge, ibid , Jan. 18.—For Lindsay Bros., Minneapolis, Minn., by H. W. Jones, ibid., Jan. 25.—Savings Bank, New Bedford, Mass. (with plans), by C. Brigham, Andrews, Jaques and Rantoul, Peabody and Stearns, ibid.—American Surety Co., N. Y., by B. Price, Archt. and Build., Jan. 14.—Store, Toronto, Can., by Curry, Baker and Co., ibid., Jan. 18.—For Black and Meyer and N. Coldwater Bros., Rochester, N. Y., by Nolan, Nolan, and Stern, In. Archt., Jan.—Store, P. Jamison, Toronto, Can., by Curry, Baker and Co., Canadian Archt., Jan.—Public Market, Winnipeg, Man., by G. Browne, ibid.—For E. Fletcher and Co., Birmingham, Eng., by E. Nicol and Goodman, Archt., Jan. 10.—Warren Chambers, Boston, Mass., by Ball and Dabney (with plan), Brickbuilder, Jan.—King Building, Boston, Mass. (with plan), by W. W. Lewis, ibid.

Commercial Buildings—Interiors.—Bank, Bolton, Eng., by Bradshaw and Gass, Amer. Archt., Jan. 4.—Whitehall Court, Victoria Embankment, London, Eng., by Arthur and Green, ibid.—Board Room, P. & O. S. N. Co. offices, Leadenhall St., London, Eng., by T. E. Collcutt, ibid., Jan. 11.—Penny Bank, Yorkshire, Bradford, Eng., by J. Ledingham, ibid., Jan. 18.—Equitable Insurance office, Manchester, Eng., by W. Waddington and Son, ibid., Jan. 25.

Court Houses.—Hennepin County, Minneapolis, Minn. (3), by Long and Keys, Amer. Archt., Jan. 18.—Imperial Law Courts, Leipsic, Germany, (view, plans part elevation), by L. Hoffman, Archt. and Build., Jan. 4.

Historical.—Gateway to University, Huy, Belgium, Amer. Archt., Jan. 4.—Chartres Cathedral, statues of west portal, ibid.—Collegiate Church of St. Hildebert, Gournay, west front, ibid., Jan. 25.—Peterborough Cathedral, under the west front arches, Builder, Jan. 4.—Ludgate in the time of Henry VIII, H. W. Brewer, ibid. —Kirkstall Abbey (with plan), ibid.—Banqueting House, Whitehall, Eng., measured and drawn by W. R. Davidson, ibid., Jan. 18.--Burgos Cathedral, interior, ibid., Jan. 25.—Burford Church (with interior), restored by A. Webb, Brit. Archt., Jan 3.—Stokesway Castle, view of north tower, Canadian Archt., Jan.—Wells' Cathedral, ibid.—Cloister of San Francesco, Brescia, measured and drawn, Brickbuilder, Jan.

Hospitals and Homes.—Soldiers' Home, Atchison, Kas., by J. G. Holland, Amer. Archt., Jan. 4.—Johnson Emergency Hospital, Milwaukee, Wis. (with entrance), Ferry and Clas, ibid, Jan. 25.

Houses, City.—Group on Eighty-sixth-st., N. Y., by G. E. Wood, Amer. Archt., Jan. 11.—At Roxbury, Mass., by E. E. Park, and R. E. Sawyer, ibid, Jan. 25.—For Mrs. J. Schmid, N. Y., by R. H. Hunt, Archt. and Build., Jan. 11.—For S. W. Stevens, Lowell, Mass., by Davis and Raynes, In. Archt., Jan.—Residence, Chicago, Ill., by D. T. Kennard, ibid.—For J. R. Hoxie, Chicago, Ill., by G. L. Harvey, ibid.—For E. Foreman, Chicago, Ill., by C. S. Frost, ibid.—For A. O. Slaughter, Chicago, Ill., by Holabird and

Roche, ibid.—For Dr. Coolidge, Chicago, Ill., by Shepley, Rutan and Coolidge, ibid.—Residence, London, Ont., by H. Matthews, Canadian Archt., Jan.

Houses, Country.—For A. N. Belding, Rockville, Ct. (with mantel details), by S. J. Brown, Amer. Archt., Jan. 4.—At Weston, Mass. (with plan), by J. T. Kelley, ibid, Jan. 11.—For E. E. Osborn, Evanston, Ill., by T. J. W. Jennings, ibid, Jan. 18.—For C. Whitman, Katonah, N. Y. (with interior), by Lamb and Rich, ibid.—Two Houses, by F. E. Wallis, Archt., and Build., Jan. 4—For E. J. Bracket, East Orange, N. J., by L. P. Smith, ibid, Jan. 11.—For W. F. Moore, Flatbush, N. Y., by Ludlow and Valentine, ibid, Jan. 18.—For R. F. Putnam, Northampton, Mass., by Putnam and Bayley, ibid.—For J. A. Sawyer, Stamford, Ct., by F. E. Wallis, ibid.—Residence, Evanston, Ill., In. Archt., Jan.—At Swanage, Eng. (with plans), by C. F. A. Voegsey, Brit. Archt., Jan. 17.—For Lord Lovelace, Elmthorpe, Eng., by same, ibid.—Cottage, Isle of Wight, by A. Webb, Builder, Jan. 25.—Frensham Hall, Haslemere, England, by Beazley & Burrows, ibid.—At Knutsford, Cheshire, England, by J. Brooke, ibid.

Interiors.—Apartment of Bela Krioztinkovich, architect, Buda-Pesth, Hungary, Amer. Archt., Jan. 4.—Mantel details for A. N. Belding, Rockville, Ct., by S. J. Brown, ibid.—Metropolitan Club, N. Y. (3), by McKim, Mead and White, ibid, Jan. 11.—In house of C. Whitman, Katonah, N. Y., by Lamb and Rich, ibid, Jan. 18.—Decoration of a hotel, Rue Daru, Paris, by M. Rich, ibid.—Hall of Mercers' Company, London, Eng., ibid.—Calumet Club, Manchester, N. H., by W. M. Butterfield, In. Archt., Jan.—Residence of Sir F. Leighton, London, Eng. (3), by G. Atshison, Archt. Jan. 3, 10, 17.—St. Peter's, London, Eng., (3) by A. W. Bloomfield, ibid, Jan. 3, 10, 17.—Chapel, Haggerstone, Eng., by C. H. M. Mileham, Builder, Jan. 18.

Library.—Newberry Library, Chicago, Ill. (entrance), by H. I. Cobb, Amer. Archt., Jan. 4.

Minnesota State Capitol.—Design by C. K. Dean (view, plan, section), Amer. Archt., Jan. 11.

Monuments.—J. H. Andresson, by J. M. DaSilva, Amer. Archt., Jan. 18.—E. Augier, by Duchesse d'Uzès and L. Parent, ibid, Jan. 25.—Ericsson Statue, N. Y., by J. S. Hartley, Archt. and Build., Jan. 18.—Meissonier, in the "Jardin l'Infante" of the Louvre, by M. Mercie, Builder, Jan. 4.

Museums.—Museum of Fine Arts, St. Louis, Mo., by Peabody and Stearns, Amer. Archt., Jan. 4.—Museum of Natural History, N. Y (east wing), by Cady, Berg and See, Archt. and Builder, Jan 4.—Pavilion for Exposition of 1900, Paris, by P. Salmersheim and A. Ventre, ibid, Jan. 25.—Portrait Gallery, London, Eng., by E. Christian, Builder, Jan. 4.

New Municipal Buildings.—New Municipal Building, King's Lynn, Eng., by Tree and Price, Builder, Jan. 11.—New Record Offices, London, Eng., by J. Taylor, Archt., Jan. 17, 24.—Clerkenwell Town Hall, (2) by C. Evans-Vaughan, ibid, Jan. 24.

Schools.—General View of Christ's Hospital Schools, Horsham, Eng., by Webb and Bell, Amer. Archt., Jan. 18.—Public School, Millvale, Pa., by Bartberger and East, ibid, Jan. 18.—Technical Institute and Public Library, West Ham, Eng., by E. Nicoll and Goodman, ibid.—At Arlington, Mass., by Gay and Proctor, ibid, Jan. 25.—Bishopsgate Institute (entrance), by C. H. Townsend, ibid.—St. John's Seminary, Wonersh, Surrey, England (with plan) by F. A. Walters, Builder, Jan. 25.

Students' Work.—Surgical Hospital, by L. F. Pilcher, Archt. and Build., Jan. 11.—Art School, Chicago Architectural Club Competition (3), by A. B. LeBoutelier, W. L. Welton, J. F. Jackson, In. Archt., Jan.—Town Church, R. A. Gold Medal and Travelling Studentship, 1895, by P. Roderick, Build., Jan. 11.—Jewelry Store Competition (2) by M. P. White, C. P. Band, Canadian Archt., Jan.

Theatres.—Vittorio Emanuele, Palermo, by C. B. F. Basile, Builder. Jan. 4.—LaFayette Square Opera House, Washington, D. C. (with two interiors), by Wood and Lovel, In. Archt., Jan.

Leading Articles.

3568. The Proper Arrangement of Water Closet and Bath Apartments. Ill. William Paul Gerhard (A discussion of the proper arrangement of the rooms or apartments in which such fixtures are placed in the different classes of buildings). Arch & Build-Jan. 11. Serial. 1st part. 2000 w.

*3581. Kirkstall Abbey. Ill. (Historical and descriptive). Builder-Jan. 4. 6000 w.

*3582. The New Imperial Supreme Law Courts at Leipsic (With the new Houses of Parliament these buildings are said to be the most important structures erected since the foundation of the new Empire twenty-five years ago. (Descriptive and historical). Builder-Jan. 4. 2000 w.

*3583. The New Municipal Theatre at Palermo (Brief history of the building, with drawing of the elevation, a longitudinal section, and two plans). Builder-Jan. 4. 1400 w.

*3584. The Chimney-piece (A finely illustrated article explaining how the chimney-piece came to be regarded as an important part of the interior, and describing some early decorations). Arch, Lond-Jan. 3. 1200 w.

3586. The Avery Memorial Library. J. A. Schweinfurth (An account of the library founded in memory of Henry Ogden Avery, at Columbia College, by his parents. It already numbers about 13,000 volumes). Am Arch-Jan. 11. 3000 w.

3587. Frogner Hovedgaard. K. Monck, in *N. Y. Evening Post* (Some remarks on the architecture of Christiania, with a description of the estate of the American consul). Am Arch-Jan. 11. 2000 w.

3588. The Origin and Styles of Pompeiian

Decoration. Alfredo Melani (The writer divides the Pompeiian decorations substantially into three styles, characterized by their principal aspects, and considers them of Greek or Hellenistic origin). Am Arch–Jan. 11. 3000 w.

3611. Combined Iron and Wood Framing of a Dwelling (A drawing showing a method sometimes employed in France). Eng Rec–Jan. 11. 500 w.

*3662. Notable Stone Buildings in New York. Barr Ferree (The first part is a finely illustrated description of the Metropolitan Club). Stone–Jan. Serial. 1st part. 1800 w.

†3677. Slow-Burning and Fire-proof Construction. Dankmar Adler (Examples of fires in buildings of each class are given, and in part first the "slow-burning" is pronounced by far the inferior system of construction). In Arch–Jan. Serial. 1st part. 3500 w.

3678. Arguments For and Against Tall Buildings (Two letters, published in the *N. Y. Sun*, from George Martin Huss and Ernest Flagg). Arch & Build–Jan. 18. 2300 w.

3679. The New Cathedral at Berlin (Descriptive). Am Arch–Jan. 18. 1600 w.

*3687. Eastern Asia; or, China, Corea and Japan. C. T. Mathews (Illustrated description of the architecture of these countries. The first part is a study in China, dealing with its domestic architecture and palaces, pagodas, temples, tombs, etc; followed by a brief account of Corea, which the writer claims was taught by China). Arch Rec–Jan-March. 5000 w.

*3688. A Picturesque Sky-Scraper. Ill. (A complimentary description of the John Wolfe building, New York). Arch Rec–Jan-March. 1700 w.

*3689. Office Methods for Architects (Particulars of the office methods of a firm in Western Ontario with copies of their printed forms for various purposes). Can Arch & Build–Jan. 1000 w.

*3690. Reminiscences of the Architecture of Sicily. A. C. Hutchison (A brief description of the representative buildings of the different styles, and the impressions produced on coming in contact for the first time with the art of the Orient and Occident, where they met on this classic island). Can Arch & Build–Jan. 2000 w.

*3691. Points for Young Contractors. David G. Baxter (Calling attention to the essentials for success in this class of work). Can Arch & Build–Jan. 2500 w.

3697. The Restriction of the Height of Buildings in Cities (Editorial approving the action being taken in this direction, and calling attention to some of the evils arising from very tall buildings in narrow streets). Eng Rec–Jan. 18. 1000 w.

3698. The Construction and Erection of a New York Pier Shed (Illustrated description of the freight and passenger shed for pier No. 13, North River, New York). Eng Rec–Jan. 18. 500 w.

3751. The New Congressional Library (Illustrated historical description) Inv Age–Jan. 2300 w.

3752. A Commercial Museum for New York (A permanent exhibition to be established which will contain a library of information as to the industries, etc., of all countries, with samples also of manufactured goods, both American and foreign. Illustrations of exterior and interior of building are given). Inv Age–Jan. 400 w.

*3758. Architecture: What Is It? J. A. Morris (A paper read at a recent meeting of the Glasgow Arch. Assn). Builder–Jan. 11. 8000 w.

*3816. Modern Theatre Stages. Edwin O. Sachs (Historical account of the movement known by name of "stage reform," which originated in Austria about twenty years ago. The writer proposes to show to what extent modern sciences and methods have already been brought into service, and how the protection of audiences and employés has been attended to. The series will be limited to the explanation of typical examples of stages erected during the last 25 years. The articles will be fully illustrated). Engng–Jan. 17. Serial. 1st part. 3000 w.

*3855. The Persistent Pilaster (Editorial criticism of the use of the pilaster, with its history). Builder–Jan. 18. 2000 w.

*3856. Municipal Buildings. H. T. Hare (Paper read before the Arch. Assn. of England. An epitome of the writer's experience and containing many valuable suggestions. Followed by discussion). Builder–Jan. 18. 8500 w.

3859. Mr. Vanderbilt's Estate, Biltmore (A description of this interesting estate, with two views of the residence, which was designed by the late R. M. Hunt). Sci Am–Feb. 1. 1700 w.

3893. Italian Mosaics.—The Cosmatesque Work at Terracina (Illustrated description). Arch & Build–Feb. 1. 800 w.

*3959. Burgos Cathedral (Illustrated description). Builder–Jan. 25. 2200 w.

3960. Architecture in America: A Forecast. John Stewardson (Probably the last contribution that the late John Stewardson made to the literature of architecture). Am Arch–Feb. 1. 3500 w.

*3985. Græco-Phœnician Architecture in Cyprus: With Special Reference to the Origin and Development of the Ionic Volute. Ill. Max Ohnefalsch-Richter (Read at the meeting of the Royal Inst. of British Arch. An account of discoveries in Cyprus and other countries which throw light upon the origin and development of the Ionic capital. Followed by discussion). Jour of Roy Inst of Brit Arch–Dec. 19. 13500 w.

*3986. The Architectural Literature of France: A Brief Historical Sketch and Review (Its source of inspiration and pioneers). Jour Roy Inst of Brit Arch–Jan 2. 7500 w.

3993. Hollow Blocks. A. T. Griffin (Setting forth the advantages of hollow terra-cotta building blocks). Brick–Feb. 1800 w.

*4001. Women in the Professions—Architecture. Margaret Mac Naughton, in *The Delineator* (General talk on the way of entering the field, and the course to follow). So Arch–Jan. 2200 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Flow of Water in 48-In. Pipes.

A SERIES of valuable experiments were made during 1894 95 on a part of the Sudbury aqueduct which has supplied water to Boston for sixteen years. These experiments were planned to determine what effect the incrustations on the interior of the pipe had on its carrying capacity, and they showed that, after cleaning out the tubercules and incrustations, the discharge increased about thirty per cent. A complete record of these tests is given by Mr. Desmond Fitzgerald in a paper before the American Society of Civil Engineers. The formula which the author chose for his investigations was an exponential formula which " would fit the case of the tuberculated pipe much better, and of the clean pipe somewhat better, than Krutter's formula. The desired formula was obtained by the method of logarithmic homologues described by Prof. Reynolds in the *Proceedings and Transactions* of the Royal Society, London, 1883. The logarithms of I (friction head in feet per foot of pipe) were plotted as abcissas, and the logarithms of v (mean velocity in feet per second) as ordinates, and from drawing straight lines, coinciding as nearly as possible with the plotted points on these logarithmic diagrams, exponents were obtained from which the following formulas are derived:"

For north pipe, cleaned.	$v=165\ I^{\frac{1}{1.91}}$	$v=171.3\ I^{\frac{1}{1.9}}$
For north pipe, tuberculated	$v=99.493\ I^{\frac{1}{2.03}}$	$v=110.43\ I^{\frac{1}{2}}$
For south pipe, tuberculated.	$v=105.41\ I^{\frac{1}{2.07}}$	

R (the hydraulic mean depth in feet) is taken as unity in this case, and does not appear. The values in the second column are rounded off and simplified, as shown in the third column. To show how closely these values agree with the determinations of other observers, the author refers as follows to a paper read before the same society by Mr. F. P. Stearns, in 1884: " By the three experiments which Mr. Stearns regarded as trustworthy, the coefficient c in the Chézy formula, $v=c\sqrt{R\ I}$, had values as shown in the second column in the table below for the velocities given in the first column. The corresponding coefficients as determined by our experiments of 1894-95 in the clean pipe (tubercules removed) calculated by the formula $c=131.88\ v^{0.045}$ (the same value used in the first formula in the preceding table) are given in the third column.

Velocity—ft. per sec.	c—Stearns, 1880.	c—Fitzgerald, 1894–95.
3.738	140.14	139.94
4.965	142.11	141.74
6.195	144.09	143.16

The concluding paragraph is of interest. " The results herewith presented led the author to the conclusion that piezometric gages laid upon the bottom of a pipe, and those screwed into the sides, gave equally accurate results, and that these piezometers, when properly arranged, can be depended upon as certainly as can other hydraulic appliances of precision. The author is particular in calling attention to this fact on account of slurs that have been cast by some hydraulicians upon piezometric observations." This statement is of vital importance. The East Jersey Water Company, following the designs of Mr. Herschel, their engineer, installed a riveted steel water-supply main, 48-in. diam., with 7-ft. sections, for supplying Jersey City with water. The pipe was designed to deliver at a hydraulic slope of 0.002 at least 50,000,000 gals. daily, but in practice it delivered but 35,000,000. The engineer explained the error in design by referring to a similar pipe at Rochester,

N. Y., about which an apparently erroneous report had been issued. This explanation would have been satisfactory, had not he discarded his own experiments, made at Holyoke in 1887, on a pipe with similar joints and giving a coefficient of roughness of 0.016, which, if applied to the Jersey City pipe, would have given a discharge of 32,000,000,—not far from the actual flow. In his report, he discards his own observations, because they did not agree with certain published formulæ, explaining the deviation of his results by saying "that piezometers do not correctly indicate the *h* of the formula" contained in Hamilton's Smith's "Hydraulics." The moral is plain. Mr. Rudolph Hering, in the *Engineering Record* (Jan. 25) and the *Engineering News* (Jan. 23), offers a criticism on the designs of Mr. Herschel, referred to above, in which he says, after explaining the conditions and warning engineers against old formulæ:

"The effect of such small projections upon the velocity in a pipe seems to be even now hardly sufficiently appreciated. D'Arcy & Bazin first called attention to this effect. In order to indicate the great difference of flow in smooth channels and such having small projections, I append the results of some of their carefully-made gagings, selected from among many, so as to correspond fairly well with the case in question, and such correspondence is sufficiently close for the present purpose. The value of the coefficient of roughness (n) was of course obtained by the experiment. Applying it to the conduit in question, its discharge is computed for each case. The other gagings mentioned herein are also embodied in this table."

Evidently, if municipal authorities or private corporations are going to continue the construction of water supplies, and engineers to stake their reputation upon the design, it is high time that they should join hands in collecting and recording data which shall be at least accurate.

Recording Vibrations in Iron Bridges.

IT is important that a railroad bridge should stand up firmly under a moving train with ordinary conditions, and that no synchronous vibration should occur. It is often difficult to determine by the eye alone whether the latter exists and whether it may not be due to a loose connection which would render the member itself useless, and the adjacent member liable to undue strain. Messrs. Pownall and Milne, in London *Engineering* (Jan. 24), describe some experiments in this direction, made by them on the Rokugo bridge in Japan.

"The instrument which was used in these experiments was a compact and

COMPUTED DISCHARGES FOR A CIRCULAR CONDUIT WITH A HYDRAULIC SLOPE OF 0.002 AND AN EFFECTIVE DIAMETER OF 47¼ INCHES.

Number. Author.	Description of Wetted Perimeter.	Coefficient of Roughness (n), Kutter.	Discharge in Million Gallons per Day.
1. Assumed for E. J. W. Co.'s conduit (1889) ..	Steel, rings about 7 feet long, riveted with lapped joints, thickness of plates one-fourth to three-eighths inch....	.0106	50
2. Stearns (1885)........	New cast-iron pipe, near Boston, very easy curves, coated with asphalt, clean	.0108	49.2
3. Brush (1882-87)......	New cast-iron pipe, in New Jersey, large number of summits, angles and curves, coated with asphalt......... ..	.0127	41.3
4. D'Arcy & Bazin (1865)	Test channel of neat cement.........................	.0103	52
5. D'Arcy & Bazin (1865)	Test channel of planed boards...........	.0118	44.8
6. D'Arcy & Bazin (1865)	Test channel, lined with pebbles three-eighths to seven eighths inch diameter..	.0169	30
7. D'Arcy & Bazin (1865	Test channel, lined with laths 1 × ⅜ inch, nailed crosswise to current, three-eighths inch apart.................	.0154	33.4
8. D'Arcy & Bazin (1865)	Test channel, lined with laths 2 inches apart............	.0216	22.9
9. Herschel (1887)......	Wrought-iron flume at Holyoke, rings about 4.5 feet long, riveted, with lapped joints, thickness of plates 0.03 foot	.016	32

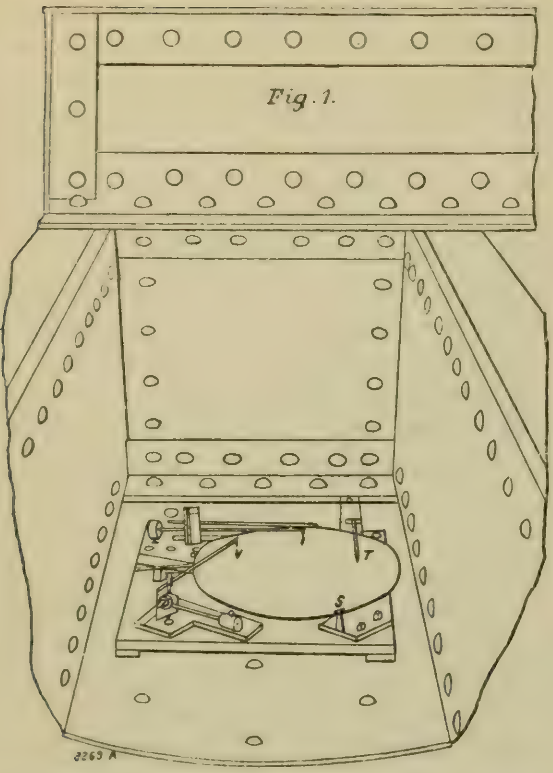
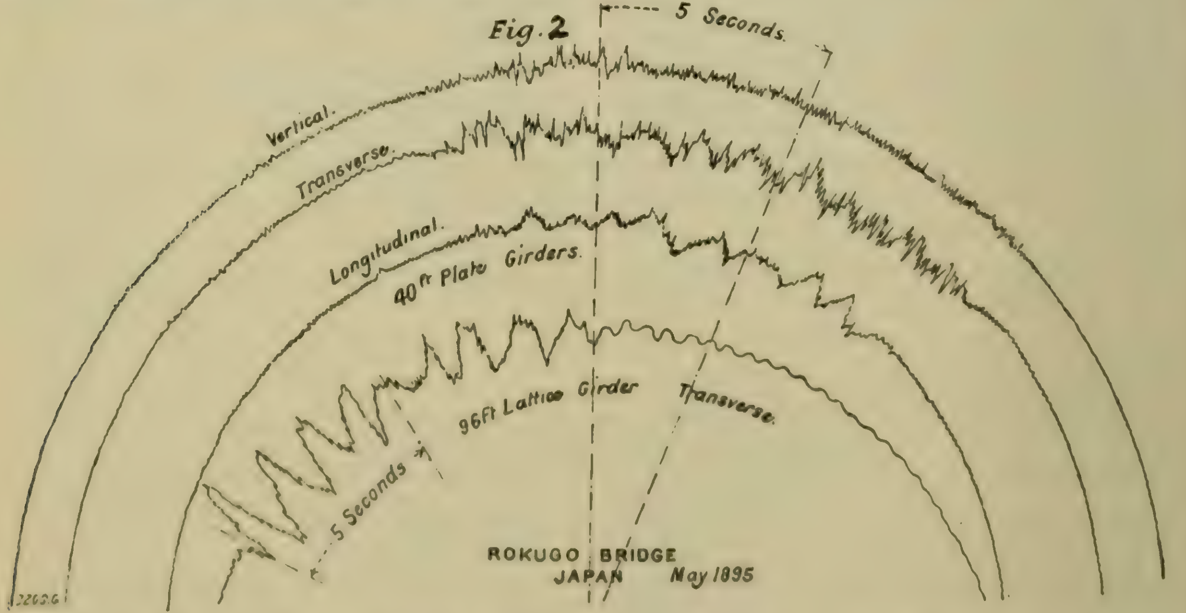


Fig. 1.

portable form of seismograph, which gives, for all practical purposes, absolute measurements of the movements to which it is subjected.

"The horizontal components of motion were recorded by means of two horizontal lever seismographs, so arranged that their writing indices were at right angles to each other. The outer ends of the three writing indices rested on the smoked surface of a glass disc, which could be caused to rotate at a uniform rate by means of clockwork placed beneath it. When these indices are at rest and the disc revolves, three concentric circles are described, but, when the instrument is shaken, the indices move proportionately to the motion they receive, and a succession of ripples or waves are drawn. To determine the rate at which the disc revolves, on which depends the determination of the time taken to describe any particular vibration, or the time occupied by the train passing the point of observation, and other things, at intervals of five seconds a mark is made upon the edge of the disc as it passes the same point. After a diagram has been obtained, the smoked surface is covered with photographer's varnish from which, after drying, a blue print may be obtained. Fig. 1 shows the general arrangement of the apparatus resting on the bottom boom of a 200-ft. lattice girder. In this figure, V is the pointer for vertical motion, L that for longitudinal motion, T that for transverse motion, and S a style that is moved by hand, or electrically, every five seconds to give the necessary time marks. The clockwork is hidden by the disc it actuates."

The results obtained by the use of the above-mentioned seismograph are shown in Fig. 2.

Fig. 2


" A glance at the diagrams shows that at least three classes of movement have been noted. First, there is an elastic vibratory motion which precedes a train; secondly, there are forced displacements due to the passing of the locomotive, its tender, and each of the carriages or wagons, which may be described as somewhat sudden bendings, which take place as each pair of wheels passes the point of observation; and, thirdly, the elastic swing of the bridge, which continues for some time after a train has passed, and which corresponds in character to movements produced by wind. The study of the first type of movement may prove to be only of scientific interest, but that of the second and third types suggest that diagrams of bridge motion may have certain practical values."

Expressed in tabular form, we give the results of six tests, which will repay close study. The high lateral and vertical stiffness of the 200-ft. girders as compared with the 100-ft. girders will be noticed at once.

VIBRATIONS CAUSED BY TRAINS PASSING OVER BRIDGES.

—	Weight of Locomotive.		Number of Carriages or Wagons.	Speed in Miles per Hour.	Time Passing in Seconds.	Maximum Transverse Motion in Millimeters.	Transverse Periods in Seconds.	Maximum Longitudinal Movement of Displacement In dices.	Longitudinal Period.	Maximum Vertical Displacement in Millimeters.	Vertical Period.	Nature of Girder.
	tons	cwt										ft.
Experiment 1. .	38	8	8 to 12	24	10	25	.47	9	..	4	.06?	100
" 2...	38	8	8 " 12	14 to 20	10	10	.41	4	..	4	.06?	100
" 3...	27	14	8 " 12	18	12	10	..	7	..	7	.08?	40
" 4.	27	17	29	11	37	20	.62	1 to 2	..	4	.33	200
" 5...	27	17	27	20.4	17.2	16	.62	4	.33	3	33	200
" 6...	28	16	28	16.4	23	12	.62	2	..	2	.33	200

"Not only do the diagrams referred to in this paper show that different classes of girders have very different characters of motion, but they also show that a vibration meter is capable of detecting small differences in the vibrations of two apparently similar girders. They also indicate that, if it is desirable, a meter might be established on a bridge, not only to record the vibrations due to wind or traffic, but also to record the times at which these disturbances took place, the speeds at which trains had passed, and their relative weights."

A Simple Hydraulic Formula.

THE current discussion in the technical press on the Jersey City pipe line fiasco has induced a communication from Mr. E. Sherman Gould in the *Engineering News* (Jan. 30). Speaking of the usual refinements in hydraulic formulæ which consider interior finish, incrustation, and joints, he says:

"Not that these conditions—particularly those of interior surface—are not controlling factors, but simply because it is practically impossible to determine these conditions for any given system of pipes, and still more impossible to predict how long these conditions may continue to exist without undergoing modifications and changes due to time and service. We know as a fact that the delivery of a pipe line must go on diminishing with age, owing to the formation of a greater or less degree of incrustation, not to speak of the probability of leakage gradually being developed. It has appeared to me, therefore that costly disappointments would be avoided by using simpler formulas, containing a more liberal allowance for unknown and unknowable factors.

"In making the calculations some years ago for my little work on hydraulics, I was struck with the fact that the adoption of a reasonable mean co-efficient for rough pipes, or those which had been some years in service, led to the following formulas, which may be said to represent the absolute maximum of simplicity, for the coefficiency is reduced to unity.

$$Q = \sqrt{D^5 + H} \quad \ldots\ldots\ldots\ldots (1)$$

$$D = \sqrt[5]{\frac{Q^2}{H}} \quad \ldots\ldots\ldots\ldots (2)$$

Also, approximately:

$$V = \sqrt{D + H + 1.6} \quad \ldots\ldots\ldots (3)$$

In these equations:
Q = cubic feet per second.
D = diameter of pipe in feet.
H = fall per 1,000.
V = feet per second.

Applying this formula to the Jersey City pipe line, we get

$$Q = \sqrt{4^5 + 2} = 45.25 \text{ cu. ft. per sec.},$$

which is about 84 per cent. of the actual present discharge through the clean, smooth pipe. Fifteen per cent. is a small margin even, for, after cleaning the 48-in. pipe of the Boston pipe line, there was an increased flow of 30 per cent. Applying the formula again, we find that, to discharge 50,000,000 gallons daily, we should require a pipe of diameter

$$D = \sqrt[5]{\frac{77.4^2}{2}} = 5 \text{ ft.}$$

instead of the 4-ft. pipe now in operation.

The Villa Mantle for Protecting River Banks.

AMONG the latest practical protective devices coming to our notice is the brick mattress devised by Signor Giovanni Villa, an Italian engineer. The mattresses used on our Mississippi improvement work are made of timber and brushwood weighted down by stone. The method has given excellent service, as timber will decay but slowly when under water; however, when submerged but part of the time, it is unsatisfactory, as decay soon sets in. The new method is thus described by London *Engineering* (Dec. 27). As shown by the accompanying cut, "this mantle consists of a series of perforated bricks or tiles strung onto zinc or other suitable wires and laid over the bank which is to be protected from scour. The wires prevent the displacement of the tiles by the wash of the stream, and in a very short time the silt deposited from the river, and the growth of vegetation where possible, render the mantle an integral part of the bank. The system has already been tested practically on a fairly extensive scale in different parts of Italy. Thus a strip of the bank of the river Olona, near Milan, nearly one thousand yards in length, was dealt with in this way five years ago, and on a recent examination proved to be in excellent condition. Similar results have been obtained in the case of protection works carried out on the banks of other streams. In particular, the French government have adopted it in some works at Bougival on the Upper Seine. The cost is said to be very low, and the work can be executed very rapidly, as much as one hundred and sixty-five yards being laid per day by one machine."

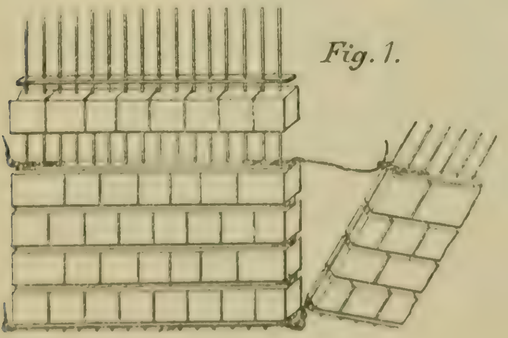


Fig. 1.

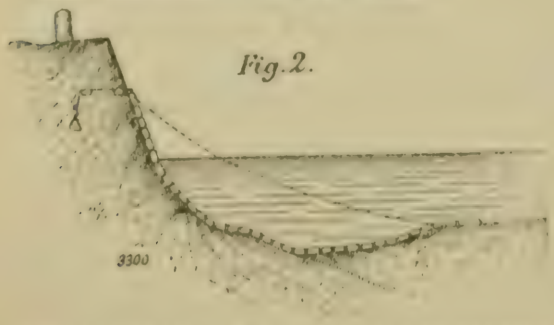


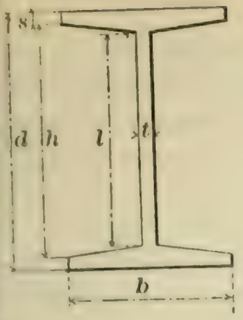
Fig. 2.

FIG. 1. DETAIL. FIG. 2. MANTLE IN SERVICE.

Standard Structural Shapes.

THE following standards, coming from authorities so eminent, are worth the consideration and attention of all engineers. *The Iron Age* (Jan. 9) says:

"As many of our readers are doubtless aware, a movement has been on foot for some time to standardize structural shapes. The Association of American Steel Manufacturers put the matter in the hands of a committee, consisting of Chas. L. Taylor of Carnegie, Percival Roberts, Jr., of Pencoyd, and Chas. S. Price of Cambria. A very great amount of correspondence has been going on with the different manufacturers, giving their views, and, as a result of this correspondence, a proposed standard for I-beams and channels suggested by the above committee has been formulated. This is shown in the accompanying drawings and tables.



Formula for area :

$$\text{Area} = t\,d + 2\,s\,(b-t) + \frac{(b-t)^2}{100}\,16\tfrac{2}{3}.$$

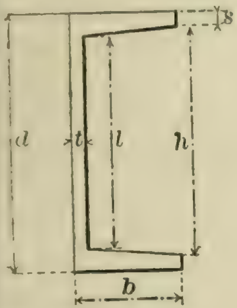
Formula for weight :
Weight per foot = area × 3.4

Formula for moment of resistance :

$$R = \frac{2I}{d} \qquad \text{Batter} = r = \frac{h-l}{2\,(b-t)}$$

$$I = \frac{1}{12}\left[b\,d^3 - \frac{1}{8r}\,(h^4 - l^4)\right]$$

I = Moment of inertia, neutral axis parallel to flange.



Formula for area :

$$\text{Area} = t\,d + 2\,s\,(b-t) + \frac{(b-t)^2}{200}\,16\tfrac{2}{3}$$

Formula for weight :
Weight per foot = area × 3.4

Formula for moment of resistance :

$$R = \frac{2I}{d} \qquad \text{Batter} = r = \frac{h-l}{b-t}$$

$$I = \frac{1}{12}\left[b\,d^3 - \frac{1}{4r}\,(h^4 - l^4)\right]$$

I = moment of inertia, neutral axis parallel to flange.

s = thickness of web
$= t$ for all except
For 20″ I s = 0.55″.
For 24″ I s = 0.60″.

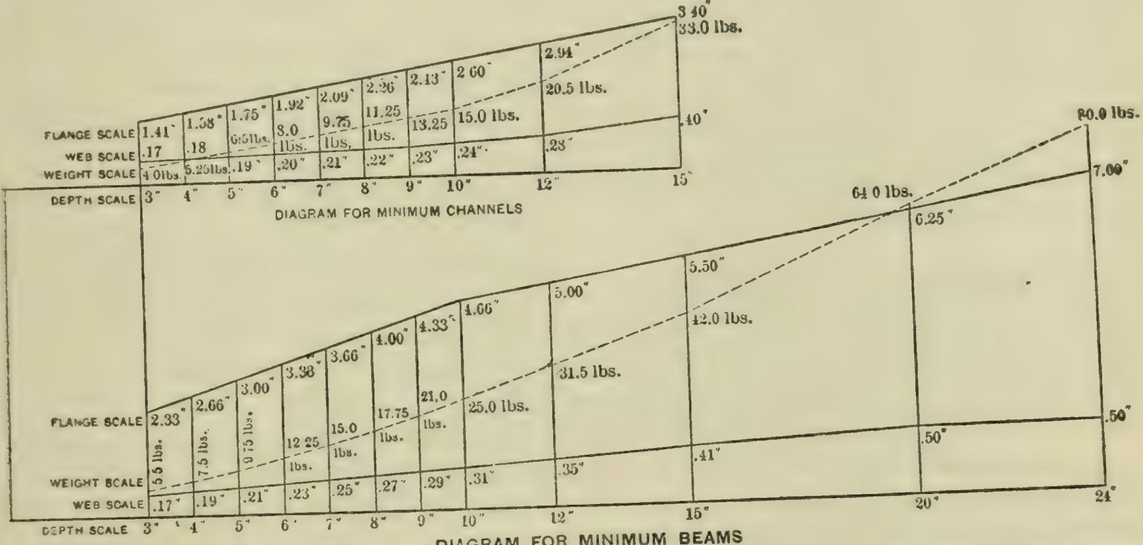


DIAGRAM FOR MINIMUM CHANNELS

DIAGRAM FOR MINIMUM BEAMS

Beams and Channels to be cut to lengths with extreme variation not exceeding 1½″. Any cutting to less variation will be charged 1-10 cent per pound extra.

PROPOSED STANDARD STRUCTURAL SHAPES.

PROPOSED STANDARD CHANNELS.*

Depth.	Intermediate weights between sizes.	Max. wt.	Min. area.
In.		lb.	Sq. in.
15..	35 pounds, then vary by 5 pounds..	55.0	9.9
12..	25 pounds, then vary by 5 pounds.	45.0	6.0
10..	Vary by 5 pounds	33.0	4.5
9..	15 pounds, then vary by 5 pounds.	25.0	3.9
8..	Vary by 2½ pounds.	21.25	3.4
7..	Vary by 2½ pounds...	19.75	2.9
6..	Vary by 2½ pounds.	15.5	2.4
5..	Vary by 2½ pounds...............	11.5	2.0
4..	Vary by 1 pound	7.25	1.6
3..	Vary by 1 pound	6.00	1.2

* For other dimensions see diagrams.

PROPOSED STANDARD BEAMS.*

Depth.	Intermediate weights between sizes.	Max. wt.	Min. area.
In.		lb.	Sq. in
24..	Vary by 5 pounds	100.0	23.3
20..	70 pounds, then vary by 5 pounds	100.0	19.3
15..	45 pounds, then vary by 5 pounds.	100.0	12.5
12	35 pounds, then vary by 5 pounds..	55.0	9.3
10..	Vary by 5 pounds..........	40.0	7.4
9..	25 pounds, then vary by 5 pounds..	35.0	6.3
8	Vary by 2½ pounds................	25.25	5.2
7..	Vary by 2½ pounds................	20.0	4.4
6	Vary by 2½ pounds...............	17.25	3.6
5..	Vary by 2½ pounds................	14.75	2.9
4.	Vary by 1 pound....	10.5	2.2
3..	Vary by 1 pound..	7.5	1.6

"As a basis a 6-inch channel was used, and a 6-inch beam. Mr. Taylor advises us that the minimum weight and sizes may be changed to some extent before they are finally adopted. In rolling 12-inch beams, Mr. Taylor states that they roll from 31½ pounds up to 40 pounds without changing rolls; from 40 pounds up to 55 pounds, which is the maximum weight, they change the rolls, and these are special sections. This applies also on 15-inch beams from 60 to 80 pounds, being special sections, and on 26-inch beams from 80 to 100 pounds. At the present time they are rolling 56 different sizes of angles. It is proposed to very materially reduce this number, and it is altogether likely that angles will be rolled in the following sizes:

Equal legs. in's......	6×4	4×4	3½×3½	3×[illegible]	2½×2½
Unequal legs in's .	6×4	5×3½	5 ×3	4×3	3½×3

Equal legs. in's......	2×2	1½×1½	1×1	¾×¾
Unequal legs. in's...	3×2½	2½×2	. ....	... ..

"It is quite likely that two or three other sizes will be added before they have been officially adopted."

Maintenance of Highways.

AT a meeting of the Improvement Society of East Orange Township, N. J., Mr. William S. Bagot read a paper, pointing out certain improvements possible in the organization and methods of the highways department of the township.

After showing that the moneys expended ($18,000) on streets and roads were entirely inadequate, and that the commissioners were hampered by their political appointers, he suggests (*Engineering News*, Feb. 6):

"In my opinion the best results would be obtained by placing the department in the hands of a single commissioner (not an appointee of the township committee), who would be an energetic man and an engineer of experience, giving him full power and means to carry out the proper purposes of his office, independently and free from interference, and then holding him strictly accountable for his official acts. He should have an assistant (at about $1,000 salary a year) to give lines, grades, etc., on street and sewer work, and an assistant in charge of road repairs and stree cleaning; also other helpers, instrumen men, etc., as occasion may demand, bu not regularly employed unless the amoun of the work warrants the expense. Th laborers should be hired directly, and organized on the basis of a limited bloc system, with a central working force t cover territory not included in the bloc system. (This system was described in th *Engineering News*, Dec. 6. 1894.) In Eas Orange there should be a block man t each two-thirds of a mile of road, whic piece of road he could keep clean and i order, making light repairs, restore th surface after it has been broken by excavation for water or gas pipes, etc. Each ma should be provided with a barrow or push cart, short square shovel, street broom large hoe, rake, pick, and iron tamper, an should wear a suitable uniform. Ther should be fifteen of these men, and th equipment would cost about $10 pe man."

In the present system there is neithe regularity or uniformity. Curbs are ofte six inches higher than necessary; road are found both flat and with excessiv crowns; street-sprinkling, when left to th judgment of the local driver, often damages the roadway. These evils are som of those which necessarily follow makeshift methods, and certainly it is of importance to municipal and township authorities that their moneys be expended in suc a way as to give satisfactory results.

DUTIES OF THE ENGINEER TO TH PUBLIC is the last clause of a code of engineering ethics drawn up and adopted b the Canadian Society of Civil Engineers year ago, and published in the *Engineerin News* (Feb. 13). The clause referred t specifies that: "The civil engineer whos advice is sought in respect to the usefulness, practicability and cost of a wor should, before expressing his opinion, obtain reliable information on all points involved in the matter submitted to his judgment, including the probable paying capacity of the contemplated undertaking He must be cautious how he recommend large preliminary outlay; should avoid connecting himself with schemes or projects of merely speculative character, always bearing in mind that his professional reputation will be to a great extent judged by the inherent merits and commercial value of the undertakings with which his name may come to be associated."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Enineering Journals—See Introductory.

Bridges.

3609. A Forty-Foot Concrete Arch Highway Bridge. Ill. (Said to be the first concrete arch built of the size in the United States, being 40 ft. span, and 7 ft. rise, and built entirely of concrete). Eng Rec–Jan. 11. 1500 w.

3811. Harlem River Drawbridge (General description, elevation, plans and diagrams, strain sheet, and truss details). Eng Rec–Jan. 25. Serial. 1st part. 1400 w.

*3830. The Albert Railway Bridge at Indooroopilly, Queensland. Ill. (The method of erection of this two-span bridge is described; each span is 340 ft. long and 41½ ft. deep at centre of curved top boom). Eng, Lond–Jan. 17. 2000 w.

*3946. Barker's Bridge Flooring (It consists of troughs riveted together. The method of construction is described and illustrated). Eng, Lond–Jan. 24. 3000 w.

*3951. On the Vibrations Caused by Trains Passing Over Iron Bridges. C. A. W. Pownall and John Milne (A series of experiments, illustrated by sketches of apparatus used and the curves recorded, to determine the transverse, longitudinal and vertical amplitude of vibration of bridges under moving loads). Engng–Jan. 24. 4500 w.

*3996. Movable Bridges in European and American Cities (A report by George W. Rafter to the N. Y. state engineer on lift bridges, with a view to their application to the Erie Canal and city of Rochester. The article is well illustrated and is a valuable contribution). Pav & Mun Eng–Feb. 1800 w.

4019. A Concrete Arch of 40 ft. Span at Belleville, Ill. (Description of construction, illustrated by sections of arch and abutments. The bridge was tested by a load of 150 lbs. per sq. ft. The article gives the proportions of the ingredients of the concrete for the several parts of the bridge). Eng News–Feb. 6. 1300 w.

4025. Quantities of Paint Required for Bridges of Various Spans. C. E. Fowler (Quantity and cost of the various paints required for highway and railroad bridges for spans of 20 to 300 ft., varying by 20 ft. difference). Eng News–Feb. 6. 300 w.

4029. The New Draw Bridge Over Frankford Creek, Philadelphia. Inset (An electrically operated bridge illustrated by detailed drawings). R R Gaz–Feb. 7. 1500 w.

Canals, Rivers and Harbors.

*3663. The Chicago Drainage Canal (A description of some of the methods of excavation, illustrated by half tone cuts), Stone–Jan. 1500 w.

3726. The Chicago Canal, and Some Sanitary Problems Connected Therewith. P. H. Bryce An address before the Engineering Society of the School of Practical Science, Toronto). Can Eng–Jan. 2000 w.

3756.—$1.50. Bank Revetment on the Lower Mississippi. H. St. L. Coppée (The various methods of channel protection and divergence are explained, with illustrated descriptions of the mattresses, spurs, anchors, barges, and other devices used. The article is exhaustive and detailed). Trans Am Soc of Civ Engs–Jan. 27500 w.

3883. The Levees of the Mississippi River. William Starling (A valuable and exhaustive article on the construction, care of, and repair of river embankments. Inset). Engng News–Jan. 30. 15500 w.

†3906. Commerce and Deep Waterways. Ill. Lewis M. Haupt (An extremely interesting paper on the transportation losses due to low water, with especial reference to the Ohio River near Pittsburg). Jour Fr Inst–Feb. Serial. 1st part. 6500 w.

4026. The Present Aspect of the Mississippi River Navigation Improvement. J. B. Johnson (A review of the organization and plan of work of the Mississippi River Commission and a note on the efficiency of the new 600 cu. yd per hour suction dredge). Eng News–Feb. 6. 2000 w.

Hydraulics.

3755.—$1.50. Flow of Water in 48 in Pipes. Desmond Fitzgerald (Over two cart loads of tubercles, which incrusted the interior of the pipe were removed, resulting in an increased flow of 30%. Flash light photographic views are given of the interior of the pipe, and the method of measuring velocities, etc., is described. The actual observations are given in tabulated form). Am Soc of Civ Engs–Jan. 5000 w.

†3773. Improved Water Discharge Recorder It is intended to keep a graphic record of the gallons flowing over a weir, by means of an automatic water head register). Ind & East Eng–Dec. 21. 1500 w.

3791. Tunnel Sections of the Nashua Aqueduct for the Metropolitan Water Supply. Ill. (Copious extracts from the specifications). Eng News–Jan. 23. 2500 w.

3794. The Capacity of the East Jersey Water Company's Conduit. Rudolph Hering (Valuable criticism upon methods of measuring the flow of water in pipes, noting especially the effect of roughness). Eng News–Jan. 23. 1800 w.

*3828. Failure of the Great Dam of Bouzey (General remarks on this and other dam failures). Eng, Lond–Jan. 17. 3600 w.

*3831. Observations on the Flow of Water in the New Aqueduct from Loch Katrine: Glasgow Corporation Waterworks. Alexander Fairlie Bruce. (The conduits are concrete lined for half their length and have a coefficient of friction of 0.0121 to 0.0125. Complete data accompany report). Eng, Lond–Jan. 17. 900 w.

3885. Curved Masonry Dam for the Water-Works of the City of Remscheid, Germany (Abstracted from a paper by Prof. O. Tutze in the Jour. of the Soc. of German Engs., by O. J. Marstrand. The dam is 13-ft. thick at the crest, 49-ft. thick at the base, 82-ft. high and curved up stream with a radius of 410-ft.) Engng News-Jan. 30. 1500 w.

*4075. Longevity of Timber for Dams. E. R. Beardsley (The writer demonstrates the superior advantage of pine over oak timber for subaqueous structures acted on by running water, and says that the method of building should be determined largely by the kind of timber available). Am Miller–Feb. 1000 w.

Irrigation.

4021. The Bear River Irrigation System, Utah. W. P. Hardesty (The article contains full details of the work and is illustrated by cuts and sections of the dam and tunnel). Eng News–Feb. 6. Serial. 1st part. 3000 w.

Miscellany.

†3676. The Relation Between Tests and Use of Portland Cements. W. S. MacHarg (The detail of improvement is discussed, to make it clear that it is positive and permanent, and for the purpose of showing that economy may be safely practiced with the present quality of Portland cement). In Arch-Jan. 4500 w.

*3750. Notes on Cement Testing. H. M. Norris (Explicit instructions as to the best methods of testing cements and mortars. The usual tensile strength, or cohesion test, is regarded as least important). Digest of Phys. Tests–Jan. 2200 w.

3767. The Sewers of Paris—An Inverted Siphon under the Seine (The sewer is lined with sheet iron and consists of a shaft at one bank connecting with a tunnel under the river, which rises gradually into the sewer on the other bank). Sci Am Sup Jan. 25. 700 w.

3780. Re-opening a Canal (A prospectus has been issued by the Lake Drummond Canal & Water Co for the reconstruction of the old, and now disused, Dismal Swamp Canal). Mfrs Rec–Jan. 24. 3500 w.

3790. The Water-Works of Curazoa (A system of concessions by which one man furnishes the town with electric light, water, ice, coal, and has built a pontoon bridge, which is illustrated.) Eng News-Jan. 23. 400 w.

3792. Effect of the Fineness of Sand upon the Strength of Cement Mortar (Tests which indicate that below 40 meshes there is no preference in sands used; the coarser grades are the better above 40 mesh; the condition of the surface of sand particles largely affects their efficiency. The results of the tests are given in a diagram). Eng News–Jan. 23. 1200 w.

3793. A New Method of Chaining Slopes. J. C. Isaac Leskard (A method of measuring horizontal distances on a slope without subsequent reduction, by the use of a protractor attachment to the chain). Eng News–Jan. 23. 700 w.

*3817. The Emptying of the Merjelen Glacier-Lake. C. S. Du Riche Preller (The water banking up against the side of a glacier formed a lake which occasionally overflowed and flooded the Rhone valley. This danger was mitigated by running a drainage tunnel into the bottom of the lake). Engng–Jan. 17. 1400 w.

3958. The Manufacture and Uses of Wire Rope. F. H. Hopkins (General remarks followed by the description of a sand handling cable plant at Niagara Falls). Can Min Rev–Jan. 2800 w.

3994. The Utility of Drain Tile. P. S. Kempton (A paper read before the Ill. Clay Workers Assn. on the beneficial effects of subsoil drainage on agricultural lands). Brick–Feb. 2800 w.

†3998. Paint as a Protection for Iron. E. A. Custer and F. P. Smith, with Discussion (The principal requisites are given as adhesion, non-corrosion, toughness, elasticity, and it must be water proof). Pro Eng's Club of Phila–Jan. 7500 w.

†3999. Notable Engineering Achievements in the Great Lake Region. John Birkinbine (Among other notable features described are the 800 × 100 ft. Sault Ste Marie Lock, the ore docks, the Chicago drainage canal, and the 3000-ft. Marquette Breakwater). Pro of Eng's Club of Phila–Jan. 5000 w.

4008 Burning of Clay. Thomas Townsley (A practical article giving the results of the author's experience). Clay Rec–Jan. 29. 3000 w.

4020. The Better Maintenance of Highways in the Township of East Orange, N. J. William S. Bacot (The article contains some valuable suggestions on the organization required to maintain good roads). Eng News–Feb. 6. 1100 w.

4022. A Dipper Dredge for Digging Phosphate Rock (Illustrated Description of a 1 cu. yd. dipper dredge, handling 50 to 70 cu. yds. per hour). Eng News-Feb. 6. 400 w.

4027. Moving a Stone Church Building in Chicago (The building weighed 6652 tons, and was 225 ft. high to top of spire. It was removed 510 ft. successfully). Eng News–Feb. 6. 1200 w.

4030. A Case of Inadequate Engineering (The results of an investigation into the work on the driveway along the Harlem River, pointing out several features open to criticism). R R Gaz-Feb. 7. 1800 w.

4054. Sixty-Ton Bucyrus Steam-Shovel. Ill. (An unusually heavily constructed dredge used in hard pan and iron ore. The thrust is derived from two strong engines on the boom itself). Ir Tr Rev–Feb. 6. 500 w.

DOMESTIC ENGINEERING

Lead vs. Iron Pipes in Plumbing.

A SYMPOSIUM of correspondence upon this subject appears in *Domestic Engineering* for January. The letters are mostly from practical men, who have had opportunity to judge the results of the growing use of wrought-iron pipes instead of lead, one of the chief reasons for which is the modern tall building, in the main stacks of which the use of lead pipe is impossible, wrought iron being the only material available for the purpose.

The longest and most important of the communications is one from Mr. C. J. Johnson, of Chicago; and, as the other shorter letters concur, in the main, with his opinion, an abstract of his views will present the general tone of disapproval of iron as a substitute for lead water pipes in buildings of moderate heights.

In residence buildings, and in business buildings of moderate size, where fire-proofing is not a part of the specifications, this necessity does not exist, and the practice of introducing wrought-iron pipe in the plumbing of these buildings certainly does not show good judgment. Lead is the most suitable material for this class of work, being pliable and susceptible of being bent and stayed at any angle to the main run; and, being of uniform bore, it presents the minimum resistance to flow, and minimum friction. Wrought-iron pipe is not of uniform bore. Its fittings are made on angles of forty-five or ninety degrees, and a fall which will allow iron pipes to be readily emptied when water is shut off is difficult of attainment. All connections with the plumbing fixtures must be made on angles of ninety degrees, leaving the lateral runs horizontal. As all fittings used on wrought-iron pipe are larger in diameter than the pipe itself, it can be readily seen that, to thoroughly empty a system of wrought-iron pipe throughout a building, is an absolute impossibility. The water thus collected in the fittings will attack and dissolve the iron exposed, and the moisture circulating through the pipes when partially empty will cause rapid oxidation of the interior surface, all of which, when water is again turned on, will be discharged into the plumbing fixtures, making a most unsightly appearance. The glazed surface of water-closets, basins, porcelain tubes, etc., will "craze" when exposed to light or to rapid changes of temperature, even for a short time, and the iron solution will soon find its way into the fissures thus made, and forever ruin the future appearance of such fixtures.

In large fire-proof buildings, where main supplies and laterals are iron and connections to fixtures are lead, this destruction of earthenware can readily be seen, even though but a small quantity of soluble salts of iron can find its way into the fixtures. In a residence building, where the water is often turned off for protection and safety during cold weather, there is no escape from this nuisance.

The destruction is extended to all washable apparel, to say nothing of articles of food and drink, many of which may be changed in their appearance and composition through chemical reaction with the iron.

Galvanized pipe, from a chemical point of view, is far more dangerous than black iron pipe. The ends of the pipe and the interior threaded part of the fitting exposed are not galvanized; hence the contamination of iron cannot be entirely done away with. Another difficulty appears, which is far more serious than the contamination of the water with salts of iron. Zinc and iron are a strong "voltaic couple," and the zinc on the inner surface of the pipes is always more or less rapidly destroyed at the expense of the iron, producing soluble salts of zinc, which are poisonous. All waters that are palatable contain carbolic acid, and many contain chlorids or sulphates. Formation of soluble salts of zinc results. Many cases of acute poisoning have resulted from drawing hot water from a galvanized range boiler in the kitchen, and using it in making tea or coffee or other articles of food and drink; and many a family physician has been puzzled to know the cause of such ailment, erroneously ascribing it to zinc chlorid used as soldering-flux on fruit cans, without suspecting the real cause.

Lead pipes quickly become coated upon the interior, and then become perfectly innocuous, whereas the oxid formed on the interior of an iron pipe is not perfectly adherent, as is shown by the discoloration of water that has stood for a little time in an iron vessel. When the increased cost of labor in putting in iron pipes is taken into account, the total cost of iron pipes is seen to be so nearly up to that of lead that the greater durability of the lead renders it cheaper in the end; it is altogether a false economy to make such a substitution in any case wherein lead pipes can be used.

Bacteria in Water from Deep Wells.

It has been a wide-spread popular opinion that the purity of water obtained from deep wells, especially from deep wells of the kind known as driven wells, might be depended upon. Of late, however, there has arisen a doubt of the accuracy of this belief, and scientific investigation has now shown it to be erroneous. In this department for February a case of sewage contamination of one of these wells was described, and examination of waters from a considerable number of springs and deep wells by the distinguished bacteriologist of the Massachusetts State board of health has now shown that bacteria are present in water taken not only from springs and open wells, but from carefully-guarded wells of quite extraordinary depth.

We find in the *Sanitary Record* (Jan. 17) an account of investigations instituted by the board, and carried out by M. W. Sedgwick, Ph. D., biologist of the board, and M. S. C. Prescott, S. B., reprinted from the twenty-sixth annual report. The results of the investigations conclusively prove that Sternberg, Abott, and other high authorities were in error in believing waters from deep sources to be free from bacteria. Frankland, in his celebrated work, "Micro-organisms in Water," evidently had doubts, but his investigations led him to believe that such waters, although, perhaps, not wholly free from micro-organisms, possessed a "high degree of bacterial purity."

But even this belief must be abandoned, in view of results obtained in the recent examinations, which included water from springs, open wells, and tubular wells.

We present in this review a few typical examples of results from each of these sources. A series of springs in a country district of southern New Hampshire were examined under conditions and with results as follows:

Springs. No. 1.—Situated in a field on edge of meadow. Water comes up through a stratum of clay. Rate, several barrels per hour. Water, clear and colorless. Date of analysis, November 29, 1894. Bacteria per cubic centimeter, on gelatine, 252,—258; on glycerine agar, 143,—167.

"Open spring No. 3.—Situated in meadow at base of a wooded hill 400 ft. high. No habitation within one-half mile. Other conditions similar to those in No. 2. Date of analysis, November 29, 1894. Bacteria per cubic centimeter, gelatine, 92,—105; glycerine agar, 72,—79.

"Open spring No. 5—Open land, near top of a hill used in summer for pasture. Soil, gravelly. Date of analysis, November 29, 1894. Bacteria per cubic centimeter, gelatine, 193,—218; glycerine agar 203,—217.

"Open spring No. 6.—Low land pasture, surrounded by shrubs and trees. No buildings anywhere near. Date of analysis, November 29, 1894. Bacteria per cubic centimeter, gelatine, 100,—43; glycerine agar, 72,—36.

"Open Well.—Close to roadside. Sandy soil. Depth, about 15 ft. Operates by bucket. Buildings, 5 rods away. Date of analysis, November 29, 1894. Bacteria per cubic centimeter, gelatine, 509,—525; glycerine agar, 204,—228.

"Open Well No. 2.—On hill top. Sandy soil. Depth, about 30 ft. Operates by bucket. House two rods away. Date of analysis, January 2, 1895. Bacteria per cubic centimeter, gelatine 248,—190; glycerine agar, 140.

"Open Well No. 3.—Near house. Conditions not so favorable. Depth, 15 ft. Bacteria per cubic centimeter, gelatine, 502,—560; glycerine agar, 469.

"Open Well No. 4.—On hill top. Near house, but yet favorably situated. Soil, sandy and gravelly. Date of analysis, January 2, 1895. Bacteria per cubic centimeter, gelatine, 335, — 332; glycerine agar, 229.

"Spring Waters on Sale.—These were taken from a freshly-opened carboy. Sample No. 1, gelatine, 223,—261; glycerine agar, 207,—197. Sample No. 2 (one day later), gelatine, 165,—157; glycerine agar, 166, —157.

"Driven Wells. — A sample from a driven well in Cambridge, depth 193 ft., in rather gravelly soil, gave, on analysis (in duplicate), 269 and 254 bacteria per cubic centimeter.

"No. 2.—A sample from a well used for a private supply, and operated by a hand pump, gave 30 bacteria per cubic centimeter. In this case the sample was taken after several minutes of continuous pumping. The depth of this well is about 100 ft., and the soil sandy and more compact than in the previous case.

"No. 3.—Depth, 454 ft. Bacteria per cubic centimeter, 206,—214.

"No. 4.—Depth. 254 ft, Bacteria per cubic centimeter, 150,—135.

"No. 5.—Driven wells at Lowell; part of the city supply. (Petcock on pump, December 21, 1894.) Bacterial analysis gave, with gelatine, 228 bacteria per cubic centimeter, with gelatine agar, 178.

"No. 6.—Cambridgeport. Driven well; depth, 198 ft.; diameter, 8 in. In a thickly-settled, level region, not more than 500 yards from Charles river estuary. Various samples from this well have been tested. Samples taken from pipe leading to tank. (*a*) bacteria per cubic centimeter, 116; (*b*) bacteria per cubic centimeter, 192,—193; (*c*) bacteria per cubic centimeter, 262,—258.

"No. 12.—Well on Second Street, south Boston. Depth, 200 ft. From description of engineer it appears that, while the pipe extends only to a depth of a little more than 200 ft., the well was originally bored to a depth of over 1,200 ft. Bacteria per cubic centimeter, 525.

"It is difficult to find deep wells in uninhabited or country districts, and our results are all derived from populous areas. It is possible that other results might be obtained from wells driven in uninhabited regions.

"It is plain, however, that water absolutely free from bacteria is not ordinarily obtained from even deep wells, and that many deep wells contain as numerous bacteria as are found in many surface waters."

Water Closets and Baths.

AN abstract of a paper by Wm. Paul Gerhardt, in *Architecture and Building* (Jan. 11), will be useful to readers contemplating the erection of residences, as giving hints upon important practical points neglect of which much detracts from the convenience and sanitation of homes.

The following are some of the cardinal requirements of a well-appointed bathroom. It should be conveniently located; it must be capable of being well heated in winter time; and it should have perfect ventilation at all times, but also be free from draughts, which involve danger of catching cold during or after bathing.

Its walls and floors should be, not only sound-proof, but also protected against dampness, steam vapor, and water. It should be well lighted and comfortably furnished. Its dimensions should be such that the bath-room should not seem cramped, or be rendered uncomfortable by the vapor of hot water. The plumbing fixtures should be well arranged and well grouped, and all plumbing, and the supply pipes in particular, should be protected against exposure to frost.

The apartment should be entirely safe from a sanitary point of view,—*i. e.*, all entrance of sewer air must be carefully guarded against; and, last but not least, the whole room must be so arranged as to be easily kept clean.

Bath-rooms should be located on the upper or bed-room floors of a house, at a point as accessible as possible to the various bed-rooms, though not too prominent.

In the smaller houses there is generally but one bath-room, which must be conveniently reached from all the chambers. A single bath-room for ordinary-sized houses is quite sufficient, particularly where the water-closet is in a separate apartment.

Larger houses have several bath-rooms, —one on each of the bed-room floors, or several bath-rooms on one floor. In the largest mansions of the rich each bed-room suite often has a bath-room attached to it, as the owner's fancy or purse may dictate.

An undue multiplication of fixtures, besides leading to other complications, may require a larger supply of hot water than an ordinary kitchen boiler can supply.

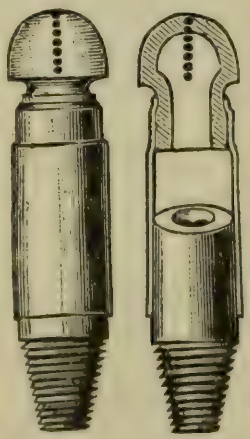
On the top or attic floor provision is often made for a servants' bath-room. A servants' bath should never be omitted, except in the smallest houses. Sometimes it may be more conveniently arranged in the basement or the laundry, or even in an alcove of the kitchen, where hot water can easily be had. This latter is an essential condition, for it is a well known fact that servants will not use a bath-tub with only a cold-water faucet, necessitating the carrying of the hot water for a bath in pails. We should encourage in our domestics the maintenance of cleanliness, as well as provide for their comfort and health, and nothing will tend more surely to secure this than the provision of a simple bath for the use of the servants. The family bath-room should be so located in the plan of the house that it may be quickly reached from the bedrooms without the necessity of crossing long halls or corridors, which, being often insufficiently heated, expose persons to the danger of catching cold. The bath-room may be located in the rear hall-room of the main house, or else in the middle of the house, or, finally, in an extension.

The objectionable plan of placing a water-closet in a bath-room is often seen, even in American houses of a pretentious character. Both sanitary and esthetical reasons demand that they should be separate. Mr. Gerhardt insists that this separation may, in most cases, be carried out by skilful planning, even in small dwellings. A bath and a water-closet have, as a matter of fact, nothing in common, except the soil pipe, with which, according to the best American plumbing practice and contrary to the English practice, both may be safely connected.

A New Gas Burner.

A NEW gas-burner, much extolled for its increase of illuminating power, is described in *Journal of Gas Lighting* (Dec. 20).

The device is a cap burner; but, instead of the ordinary continuous slit, it has a series of small holes, arranged as shown in the figure. It is scarcely comprehensible that this slight difference should make a difference of 233 per cent. in the illuminating power in a burner consuming 3.1 cubic feet of gas per hour; yet this gain is alleged on no less an authority than M. H. Leicester Greville, the chemist of a large gas company in England, and a frequent contributor to the current literature of the gas industry.



THE ENGINEERING INDEX—1896.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

Heating and Ventilation.

3612. Heating Two Blocks of Flat-Houses from One Boiler Plant (Description with plans). Eng Rec–Jan. 11. 700 w.

*3693. A New System. Leicester Allen (To compete with steam or hot water by forced circulation of hot air). Dom Engng–Jan. 1600 w.

*3694. Heat Regulation. Fred W. Powers (In a blast apparatus applied to a hot air furnace). Dom Engng–Jan. 600 w.

*3695. Blast Heating. George D. Hoffman

(Application of the new system. Illustrated detailed description). Dom Engng–Jan. 900 w.

*3696. Electricity vs. Hot Air (Some considerations on whether electricity will supplant hot air, by a practical furnace man). Dom Engng–Jan. 1000 w.

3795. Comparison of the Methods in Common Use for Driving Fans. William G. Snow (Considered with reference to first cost, expense of running and adaptability). Heat & Ven–Jan. 15. 2500 w.

3807. Forced Blast Warming with Furnaces. George W. Kramer (An able discussion of a method of warming and ventilating which appears to be coming into favor. It is a combination of forced circulation with warm air furnace heating). Met Work–Jan. 25. 4000 w.

3812. Hot-Water Heating in a St. Louis Residence (Detailed illustrated description of hot-water heating plant—closed system). Eng Rec–Jan. 25. 2800 w.

†3888. Expired Air and Problems of Ventilation (Important contradictions of certain accepted views. The injurious effects of expired air are attributed almost wholly to increase of carbonic acid and decrease of oxygen. Doubt is thus thrown upon advanced theories of ventilation. These views seem likely to arouse discussion). Pop Sci M–Feb. 900 w.

3889. The Heating and Lighting of the Philadelphia Bourse (Illustrated detailed description). Eng Rec–Feb. 1. 3000 w.

3905. The Fan and Furnace System of Heating and Ventilation. Walter B. Snow (The system is claimed not to be new, as some have supposed. An instance of a successfully working apparatus of this kind, as erected in the mansion and greenhouses of Baron Hugel, at Schonbrunn, Germany, 45 years ago is given, and it is also stated to have been used for heating large factories in England about the same time. The introduction of small cheap motors now promises to greatly extend the use of the system). Met Work–Feb. 1. 1000 w.

3908. The Incandescent Fire Frame. How to Burn Coke (Describes the "incandescent fire frame," whereby it is claimed much more satisfactory results are obtained than by the more ordinary grates, etc.). Am Gas Lgt Jour–Feb. 3. 800 w.

3969. Electric Heating. W. S. Hadaway, Jr. (Electric heating is treated in this paper more particularly with reference to house heating, car heating, &c., than with reference to its technical side as a branch of electrical engineering, although the latter is not ignored. It is an exhaustive dissertation upon the subject, by an entirely competent author, and gives a full outline of progress to date, while it also in some measure forecasts the future of the art). Heat & Ven–Feb. 6000 w.

3970. Heating and Ventilating of Large Churches. Henry B. Prather (Paper read before the Am. Soc. of Heat & Ven. Engs. How to proceed from beginning to end—architect and heating engineer co-operating—in order to achieve marked success in heating and ventilating churches. Causes of failure are stated, and remedies for them suggested. A good paper, with discussion). Heat & Ven–Feb. 3500 w.

3971. Screwed Fittings for High Pressure. Hugh J. Barron (Paper read before the Am. Soc. of Heat & Ven. Engs. A practical paper in which the superiority of forged fittings over cast fittings is urged. Discussion). Heat & Ven–Feb. 900 w.

3972. Methods of Insulating Underground Systems of Steam Piping. R. C. Carpenter (Read before the Soc. of Heat & Ven Engs. Results of experience, with diagrams showing loss of heat from pipes under different conditions. Discussion). Heat & Ven–Feb. 3500 w.

3973. Forced Blast Warming with Furnaces. George W. Kramer (Read before the Am. Soc. of Heat & Ven. Engs. An illustrated paper dealing with both the theoretical and practical principles involved in this system of heating, with examples of its successful application. Discussion). Heat & Ven–Feb. 5000 w.

3975. The Cooling of Closed Rooms. Hermann Eisert (Read before the Am. Soc. of Heat & Ven. Engs. Cooling rooms is treated as negative heating, exterior things being heated by heat abstracted from the enclosure. Equations for positive heating apply to negative heating when signs are changed. A study in artificial refrigeration. Discussion). Heat & Ven–Feb. 6000 w.

4014. Operating a Steam-Heating Plant. W. H. Wakeman (The case of a plant where exhaust steam is used under 1 lb. pressure, in connection with live steam coils, one supplementing the other). Am Mach–Feb. 6. 1600 w.

4039. Hot-Blast Heating System in a Boston Church (Illustrated description of an interesting installment. A good study in this system of heating. The air is taken in at an altitude of fifty feet to avoid the introduction of dust). Eng Rec–Feb. 8. 800 w.

Plumbing and Gas Fitting.

*3692. Lead vs. Iron (Opinions of those who are well qualified by knowledge to speak. All decry the growing substitution of iron for lead pipe in plumbing). Dom Engng–Jan. 2400 w.

3701. Plumbing in the Carnegie Building (Illustrated general description of the water-supply system, pump and tank connections). Eng Rec–Jan. 18. 1400 w.

Miscellany.

†3562. A Practical Point in the Use of Disinfectants and Antiseptics. A. G. Young (This article demonstrates that comparatively inefficient antiseptics may be made active and efficient by applying them at proper temperatures—as first intimated as possible by Koch, but until now, not much considered. Even a solution of common washing soda, when heated, becomes active as a disinfectant). San–Jan. 1600 w.

3974. A Draft and Blast Pressuure Gauge. J. H. Kinealy (Read before the Am. Soc. of Heat & Ven. Engs. Describes a new instrument by which pressures can be indicated to within 0.01 inch of water column. Discussion). Heat & Ven–Feb. 750 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Domestic Engineering.

Preservation of Gas and Water Pipes from Electrolytic Action.

THIS subject has been given most careful attention, and electrical engineers are apparently making good progress in methods for preventing injury to earth-covered pipes by return currents of the trolley systems. Considerable exaggeration has characterized the popular newspaper accounts of the effects of electrolysis upon gas and water-pipes; but this exaggeration has done no harm, since the injury is an admitted fact, and needs to be guarded against if future trouble is to be avoided.

The present status of progress in the prevention of this evil is set forth by Mr. John Gray in *The Electrical Review* (Jan. 3). The corrosion takes place, not at points where the deflected currents enter the pipes, but where the currents, having passed through the pipes a certain distance, leave these temporary conductors to pass back to the main circuit. The resulting corrosion is proportional to the magnitude of the deflected current, but, as it also depends upon the nature of the surrounding earth-covering, it varies with the quantity of moisture and saline constituents present in the soil. The deflected currents in the single trolley system are shunted from the rails to the pipes through the more or less moist intervening soil, and go back to the main circuit the same way. In some cases the part of the main current thus shunted from the rails amounts to forty or fifty per cent.

Mr. Stuart Smith's investigations in San Francisco led to the discovery of positive and negative zones. "He found that there was a zone in the neighborhood of the power station, where the pipes were positive to the rails; then a short neutral zone; and beyond that a zone—by far the largest—where the pipes were negative to the rails. The resistance of the pipes was found to be made up almost entirely of the resistance of their joints, the section of metal in the pipes having very little influence. This fact explains the unexpected result that the resistance of the gas pipes was found to be rather less than that of the water pipes, the joints of gas pipes having usually less resistance than those of water pipes. This discovery of Mr. Stuart Smith's—that the resistance of underground gas and water pipes is located almost wholly at their joints—has an important bearing on the remedies proposed for getting rid of electrolytic corrosion. In many of the proposed plans the current in the pipes is increased instead of diminished. Evidently at each high-resistance joint a stray current will pass round the joint through the ground, and accelerate corrosion where it leaves the pipe surface. Unless gas and water pipes have been laid down with joints of good conductivity, any effective scheme for reducing electrolytic corrosion in these pipes must reduce the current flowing in them to a minimum."

With reference to a statement made in Mr. Wilkinson's "Notes on Electric Tramways" in the United States and Canada,—which mentions the various phases through which attempts at preventing electrolysis have passed,—Mr. Gray quotes from the work named the following passage:

"As the earth presents an almost infinite mass compared with the rails, it was assumed, in the first instance, that a return of least resistance would be secured by well earthing the negative poles of the dynamos. The coal bill, however, stimulated inquiry into the losses in transmission of electric energy. On many lines of five to ten miles, the voltage at the most distant section between trolley wire and rails was only fifty per cent. of that generated at the station. Some improvement was made by sinking deeper earths into moist soil and connecting the same to more distant points on the rails. But at the best this was unreliable and variable, and it was noticed that improvement was more marked when attention was turned to the rails themselves as the best return conductors."

Upon this statement the following comment is made: "The conductivity of the rails was improved by bridging over the high-resistance joints by iron and copper bonds. In the next stage, the rails were connected at intervals to the water and gas pipes,—a step which created a satisfactory reduction of resistance in the return circuit, but led to a great increase of electrolytic corrosion and pitting of the gas and water pipes. To mitigate this action, the affected parts of the pipes were connected by cables to the negative poles of the dynamos. This led to the use of a supplementary wire consisting of a bare copper rod, laid between the rails, and connected to the rails on each side of the fish plates. But, as this supplementary conductor made no allowance for the increase of the current as the power station was approached, it was considered better to adopt separate return feeders connected to the rails every five hundred feet, these feeders being increased in section and number as the lines neared the generating station. These feeders were not insulated, and consequently they were only a partial improvement on the supplementary wire."

" Mr. Wilkinson considers that the separate feeder system would completely get rid of the stray currents, if they were insulated. He says: 'Let the negative poles of the dynamos be directly connected to the rails by insulated cables, but not to the earth at the station, and the current will then be kept within the rails and return feeders. The only chance for current to pass to earth would be as a shunt round bond joints of high resistance or insufficient conductivity; and, should this occur, it will only cause electrolytic corrosion at such joints, and not on underground pipes and cables.' This view of Mr. Wilkinson's appears to be erroneous. There will still be a current from the pipes to the earth under the end of each feeder where it is connected to the rail. The corrosion will therefore not be got rid of by this plan, but only more widely distributed over the pipes. That in itself, of course, is an advantage, but something more requires to be done.

" Mr. Jenkins thinks electrolysis can be prevented only by keeping all parts of the rails at the same potential,—a thing impracticable in practice, since Mr. Gray pointed out that it would require an infinite number of rail feeders; but the potential of the rails may be regulated according to a plan proposed by Mr. Jenkins: (1) by adjusting the resistance of the return feeders so that they have all the same drop when equally loaded; (2) by working the return feeders at the same density, and therefore with a drop depending directly on their length. In the first case the return feeders are run in parallel at the station off dynamos in parallel; in the second case, the feeders must be run off separate dynamos at different voltages, or some device must be used to vary the voltage."

This system Mr. Gray thinks more perfect than Mr. Wilkinson's, but it will not completely get rid of electrolytic corrosion. Mr. Harold P. Brown's plan is considered by Mr. Edison (and is also commended by Mr. Gray) as good, but Mr. Gray thinks it would be improved by combining it with the system proposed by Mr. Jenkins.

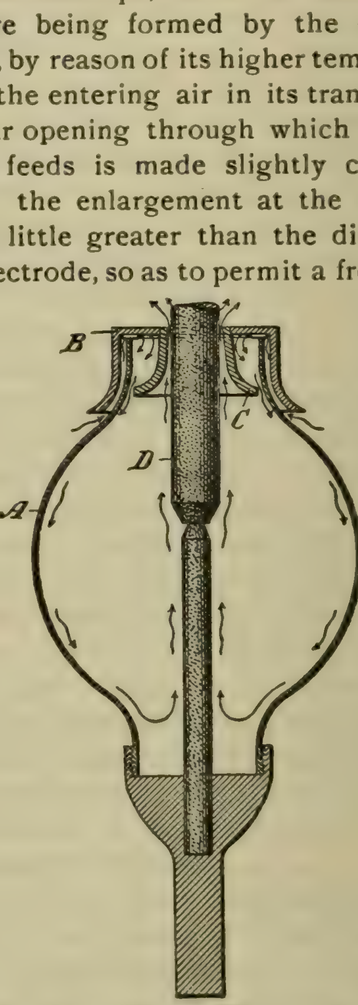
" Mr. Brown's plan is to keep all parts of the underground pipes at least a few volts below the rails and the surrounding earth. If this is carried out, there can, of course, be no current passing anywhere from the pipes to the earth, and consequently no electrolytic corrosion of the pipes. Mr. Brown attains his object by connecting the pipe systems near the power-house by an insulated feeder to one of the dynamos with a voltage twelve volts in excess of the normal voltage of the other dynamos whose negative terminals are connected to the nearest point of the rails. This has the effect of keeping the pipes near the power-station a few volts below the rails above them, and, of course, puts the potential of pipes still further off, below that of the rails by a greater amount.

The drawback to this plan is that it considerably increases the flow of the current in the pipes, and thereby increases corrosion at high-resistance joints. Mr. Brown obviates this somewhat by prolonging his insulated feeder and connecting it to the rails at their most distant point, whereby the great difference of potential between the rails and the pipes at that point, and the consequent flow of current through the pipes, are reduced. Though this system is cheap and considerably reduces corrosion, there must still be a considerable current in the pipes, and, in view of the results of Stuart Smith's experiments already mentioned, this must always produce considerable corrosion in the course of time at the pipe joints. A combination of Mr. Brown's system with the equipotential rail system proposed by Mr. Jenkins would lead to an improvement on both systems, as only the comparatively small stray currents between the feeder ends would be collected in the pipes, and harmlessly drawn off by Mr. Brown's clamp and insulated feeder.

" By such devices there can be no doubt that electrolytic corrosion of pipes, if not completely eliminated, can be very much reduced."

Ventilated Inclosed Arc.

To avoid the use of the higher drop of potential hitherto needed for inclosed arcs as contrasted with open-air arcs, the flattening of the carbon points (which results in greater or less obscuration of the light when the usual potential drop is employed with inclosed arcs), or the mushroom formations upon the carbons which result in these arcs when a lower potential drop is used, Mr. Louis B. Marks, of New York, has devised a ventilated inclosed arc. The device is described and illustrated in *The Electrical Engineer* (Jan. 15), from which we make an abstract. The envelope, *A*, is provided at the top with a loosely-fitting cap, *B*, touching the cylinder only at four projections, in the center of which is a circular or conical tube, *C*, through which the positive electrode, *D*, is fed to the arc. The negative electrode, by reason of its slower rate of consumption, may be smaller in diameter than the positive. The outer portion of the cap is enlarged into a bell-shaped flange, the rim of which is brought closely adjacent to the exterior wall of the envelope. Thus there is provided a narrow annular passage for the outside air into the envelope, one of the walls of this passage being formed by the envelope, which, by reason of its higher temperature, heats the entering air in its transit. The tubular opening through which the electrode feeds is made slightly conical in shape, the enlargement at the top being only a little greater than the diameter of the electrode, so as to permit a free feed of the latter and to afford an obstructed egress for gases from the envelope.



Ventilated Enclosed Arc

The lower part of the tube is flanged away from the electrode as shown, this form serving as a deflector for the upward currents around the positive carbon, the flange at the same time forming a deflecting-wall for the ingoing air and directing the latter outwardly toward the walls of the envelope. The tendency with this arrangement is for all egress to take place by way of the central tubular opening, and all ingress by way of the bell-shaped chamber.

The arrangement of the cap, as above described, deflects the ingoing air into the downwardly-moving portion of the convection current, where it is intimately mixed with the gases already formed in the envelope and raised in temperature, so that it is intensely hot by the time it reaches the arc.

A highly-important result which follows from the distribution of air-currents as described is that the resistance of the arc-stream, instead of being considerably increased, as is the case with other inclosed arcs, remains practically the same as in an open-air arc. The length of arc for a given drop of potential is therefore practically the same as that of an open-air arc of the same drop of potential.

Because of the flow of convection currents of arc gases mixed with atmospheric air, the electrodes do not burn blunt, as in ordinary inclosed arcs, but have much the same shape as points formed in open air. The crater formed in the positive is substantially uniform in curvature, while the apex of the negative is pointed and well centered with reference to the crater of the positive. Thus there is practically no obscuration of light, as in the usual inclosed arcs where the electrodes burn to blunt points. The light is claimed to be steady and efficient at practically as low drop of potential as with open-air arcs.

In addition, it is asserted that lamps with this type of envelope can be run at forty-five or fifty volts, and the carbons have a life of fifty hours. The difficulties named above arise from the isolation of the carbons from oxygen, and the ventilation appears to be just the remedy needed.

German Report on Glow-Lamps.

A TRANSLATION of a report of a committee of representatives of German electric-supply undertakings, from *Electrotechnische Zeitschrift*, is printed in *The Electrician* (London, Jan. 3). This report deals with glow-lamps and their faults, with a view to their improvement, and describes an elaborate experimental investigation, with the results and conclusions arrived at by the committee. We will present the main features of this important report in the form of an abstract.

The first question to be settled was the determination of existing faults, and how far general complaints of quality and life were justified by the facts.

In general, these experiments have shown that the complaint of consumers—*viz.*, that the lamps were bad—is quite justified. The reasons for this opinion are found in careless sorting, careless marking, low efficiency, and short life. Every electrician who is accustomed to make photometrical tests will have found that the sorting and marking of lamps of nearly all makers leaves much to be desired. In fact, nearly always the candle power and watt consumption differ from the figures guaranteed.

Tests made on about seventy 16-c. p. lamps for 110 volts, and supplied by eight different German firms, showed a variation in the candle-power from 7.82 to 22.85 (*Normal-Kerze*). While the lamps were marked for a watt consumption of 3¼ to 3½ watts per candle, the current absorbed varied from 0.43 to 0.63 ampere, and the watt consumption per candle from 2.8 to 6.3 watts.

Tests made on another twenty 16-c. p. lamps for volts, supplied by a well-known firm, showed a variation in the candle-power of from 10.21 to 21.6 candles, or more than 50 per cent. These lamps were specially supplied for testing purposes, and consumed 4.1 watts per c. p.

Of five 16 c. p. 3½-watt lamps, made by another well-known firm and picked out of a larger quantity, one gave out at once, another emitted only 10.21 c. p., a third 13.6, c. p. and the remainder 16.02 and 16.63 c. p. The average watt consumption was 3.7 watts per candle.

In the case of another ten 16-c. p. 110-volt lamps, made by a third well known firm and also taken from a larger quantity, the candle-power ranged from 15.9 to 22 candles, and the average consumption was 3½ watts, but, after forty-eight hours, the candle-power had fallen by 40 to 60 per cent., while the average watt consumption had risen to 5.6 watts per candle.

In 2½-watt lamps examined the conditions were found to be the same. Only a few lamps gave one candle for every 2½ watts, and most makers supplied 3½-watt lamps as 2½-watt lamps without any scruple.

Of course these results are calculated to destroy confidence in the statements of the manufacturers of glow-lamps, and they have only themselves to blame for the discredit. A reason is assigned for the fact that the difference in illuminating power between an 8-c. p. lamp and a 20-c. p. lamp which has been purchased as a 16-c. p. lamp is not at once detected. Everyone who has carried out photometrical work will know that, even for a trained eye, such detection is difficult. The reason for this is mainly that the specific luminous power—*i. e.*, the luminous power per unit of surface—is generally the same in lamps of different candle power. If a 16-c. p. lamp is placed in a group of 20-c. p. lamps of the same specific luminous power, then for most eyes it is difficult to observe the difference, and for the general public probably it is impossible. If the sorting and marking of lamps are badly done, examinations of lamps as to economy and life show no better results.

The useful life of lamps is here meant,—that is, the time in which the candle power of the lamp becomes lessened about twenty per cent. A lamp deteriorated to that extent should be replaced, although it may continue to give light for a much longer period. Generally a period of 800 to 1,000 hours is given for 3- to 3½-watt lamps. Formerly a period of 1,000 hours was usual. As a rule, however, less than 800 hours is not given. Such life can easily be attained in high-vacuum lamps, when life is understood to be the time from the first use of the lamp to its final giving out. On several occasions lives of 1,500 to 2,000 hours have been obtained. Such figures are, however, of absolutely no value, as all lamps, before giving out, have already reached a small candle-power, and are insufficient.

By a "candle power" the "mean candle power" should be understood, measured in two directions vertical to each other. The candle power varies, as is well known, according to the position of the lamps, and can vary as much as twenty per cent. between two positions. It is difficult to say in which position a lamp possesses its largest candle power, even when we are comparing lamps of the same kind. It will be nearly correct, if the lamp is placed in such a position on the photometer that an imaginary straight line passing through the terminals of the filament is at right angles to the photometer bench. By "mean candle power" will then be understood the average attained by this measurement, and a second one in which the imaginary line is rotated through 90°.

If this "useful life" and "mean candle power" be employed for calculations, then bad results are obtained with all lamps at present in the market. As an instance, it may be mentioned that in ten 16-c. p. 3½-watt-lamps of well-known makers the average actual life was 1,450 hours, and six lamps even attained a life of over 2,000 hours. The "useful life," however, was only about 400 hours. Five lamps of the same size, of another maker, had an actual life of 741 hours, and a "useful life" of 366 hours. Ten lamps of the same size, made by a third firm, gave an average actual life of 1,435 hours; six lamps burned for more than 2,000 hours; the "useful life," however, was only 150 hours.

It must be remembered that the lamps examined were those produced by manufacturers of the better class; the lamps produced by smaller concerns are not likely to be even as good.

In ordinary lamps, such as consumers buy in shops, the "useful life" should never be taken to exceed 400 hours, and, therefore, in calculation, this figure should be employed, instead of 800 to 1,000 hours.

The remarkable fact is clearly brought out in this report that, during the fifteen years since glow-lamps have been in use, they have deteriorated, instead of improved.

The report concludes with a draft of a specification for the supply of lamps of this kind, which is recommended for adoption when contracting, and it includes a standard of voltage, candle power, and watt-consumption with which they must accord, when tested, within plus or minus 2 per cent. in the voltage, and plus or minus 6 per cent. in the two other requirements. It also includes a description of the tests, and a guarantee, to be given by the seller, that, at the end of the term agreed upon as the useful life of the lamps, they shall not have deteriorated more than twenty per cent. in illuminating power.

Present Status of the Storage Battery.

M. MAURICE BARNETT, in a paper recently read before the Northwestern Electrical Association (*Electrical Engineer*, Jan. 22), attributes the change of attitude of electrical engineers and station managers toward the storage battery to four causes.

"First: litigation no longer stands in the way of the use of any of the standard types of batteries. Second: the application of special types of batteries to special kinds of work has resulted in a vastly improved performance of battery plants in meeting the exigencies of station work. This refers specially to performance of battery in acting as a reservoir for storing the energy represented by the difference between the average and the maximum load, as a regulator of pressure on circuits subject to varying demands, and as a transformer using high voltage charging currents and discharging at any lower voltage desired. Third: it is generally recognized that plants part steam power and part storage battery are cheaper than all steam power and part storage battery plant would be for the same work. Fourth: the use of batteries in sub-stations frequently permits a saving in conductors between the central and the sub-station.

"With regard to litigation, it may be said that formerly, when one bought a storage battery, one contracted the liability to a law-suit at the same time. It is now generally known that the incubus on the storage-battery business has been removed. One large company, ably managed, has obtained control of this business by securing to itself the right to manufacture in the United States storage batteries of all the important types heretofore developed."

The National Electrical Exhibition.

OF this exhibition, to be held in New York in May, of the present year, *The Electrical World* (Feb. 15) says that "the numerous contracts already closed by the National Electrical Exhibition Company assures the success of this enterprise, which contains so much of interest to all those engaged in the electrical industries. All of the larger companies have taken space and the majority of them have planned features that will be both instructive and interesting to the general public, showing not only the practical applications of electricity, but how results are accomplished, etc.

"All the branches are already represented, exhibits of electric lighting, electric railways, telephones and telegraphs being in preparation, as well as displays of electrical supplies. This being the first exhibition of the kind ever given in New York, there appears to be a general desire on the part of all concerned to make its proportions truly representative of the electrical industries.

"One of the most attractive and instructive exhibits will be that of the Edison Electric Illuminating Company of New York. This display will occupy a space of over 1000 square feet, and will comprise a complete demonstration of the applications of electricity for domestic purposes. The most improved methods of house lighting will be shown in detail, and electric heating; also cooking by electricity."

The indications are at present, that this is to be one of the most important electrical events of the year, when taken in connection with the great gathering of electricians which will take place, also in New York, while the exhibition is going on.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

*3565. Electric Lighting in 1895 (The history of the electric light industry in the United Kingdom). Jour Gas Lgt-Dec. 31. 900 w.

*3579. The Electric Lighting of Walsall. Ill. (Descriptive). Elec Rev, Lond-Jan. 3. 2000 w.

3618. The Edison Electric Illuminating Co.

of New York. Ill. Jos. Wetzler (A full historical account of the growth and progress of this company). Elec Eng-Jan. 8. 16000 w.

*3632. The Glow Lamp Question in Germany (Report of a committee of Representatives of German Electric Supply Undertakings. From the *Electrotechnische Zeitschrift*). Elect'n-Jan. 3. 3000 w.

*3634. Ayr Electricity Works (Illustrated description). Elec Eng, Lond-Jan. 3. 5500 w.

3644. Insulation and Testing of Arc Circuits. Alex. Dow (A discussion regarding the insulation resistance necessary, and practical tests required, with circuits of 100 arc lamps in series, the conductor being "weatherproof" wire, strung on glass insulators in the usual manner). Elec Engng-Jan. 2000 w.

3664. The Absorption of Light Rays Through Transparent and Translucent Glass. Th. Stort (Considering whether losses of light take place and the extent, etc.). Pro Age-Jan. 15. 800 w.

3670. The Marks Ventilated Enclosed Arc. Ill. (An envelope designed by Louis B. Marks, in which a limited circulation of air takes place). Elec Eng-Jan. 15. 700 w.

*3683. High Tension and Low Tension Supply. Albert Gay (The object of the article is, if possible, to reduce the friction existing between the votaries of these two systems. The faults of each are enumerated, and their effect upon each other pointed out). Elec Rev, Lond-Jan. 10. 2800 w.

3770. American Apparatus in the Municipal Lighting Plant, Odessa, Southern Russia (Descriptive of the plant and the special and peculiar requirements that had to be met). Elec Eng-Jan. 22. 1400 w.

3771. Modern Apparatus vs. Existing Conditions. W. J. Buckley (Abstract of a paper read before the Northwestern Elec. Assn., Milwaukee. Points of interest in electric lighting, with suggestions to buyers of new apparatus). Elec Eng-Jan. 22. 3500 w.

3772. Storage Batteries in Central Stations. Maurice Barnett (Abstract of a paper read before the Northwestern Elec. Assn. Reviewing the causes of change in public sentiment in regard to the storage battery, and considering, in a general way, the adaptability, performance and economy of the storage battery in a central station). Elec Eng-Jan. 22. 2800 w.

3863. The Cost of Incandescent Lighting from Central Stations. W. D. Marks (An argument and incentive for higher economy lamps). Elec Eng-Jan 29. 1000 w.

*3890. The Depreciation of Electric Arc Lighting (Critical review of a paper by Albert Scheible, entitled "Illumination *versus* Glare"). Jour Gas Lgt-Jan. 21. 1300 w.

3901. Illumination of the Municipal Casino of Royan (Illustrated description). W Elec-Feb. 1. 1000 w.

*3964. German Wiring Rules (Abstract from the *Elektrotechnische Zeitschrift*. Abstract of the more important rules, which apply to electrical installations with potentials up to 250 volts between any two conductors or one conductor and earth, with the exception of underground networks and electro-chemical plants). Elect'n-Jan. 24. 1200 w.

Power.

*3578. The Electrolytic Action of Return Currents in Electrical Tramways. John Gray (Reference is made to the experiments of Mr. Stuart Smith, and the writings of Mr. Wilkinson, with Mr. Jenkins' discussion on Mr. Wilkinson's paper. Mr. Brown's system is explained and comments are made). Elec Rev, Lond-Jan. 3. 2000 w.

*3636. Electricity in Mining. Sydney F. Walker (A review of the progress of the past twenty years). Elec Eng, Lond-Jan. 3. 2000 w.

3646. The Detroit Railway; Its Power House and Other Features (Illustrated detailed description). Elec Ind-Jan. 2000 w.

*3649. A Novel Electric Brake. Frank M. Ashley (Illustrated description of a new system with a small storage battery in each car). Elec Pow-Jan. 700 w.

*3652. The Compound Dynamo. George F. Sever (Lecture delivered before the Henry Electrical Club. The paper treats of the function, uses, methods of working, etc.). Elec Pow-Jan. 3000 w.

*3653. Alternators. M. I. Pupin (Historical review of the steps that led to the use of the alternator and the transformer. The method of armature winding is illustrated, and ways of constructing the alternator). Elec Pow-Jan. 2000 w.

3673. Selecting an Electric Motor. G. H. Zahn (Difficulty in the selection due to the imperfect manner of rating electrical machinery). W Elec-Jan. 18. 2300 w.

3675. Official Report of Experiments in Electric Propulsion on the Erie Canal (Full text of the report of Charles R. Barnes, from which it will be seen that the system is looked upon with much favor). W Elec-Jan. 18. 2200 w.

3680. Three-Phase System at Concord, N. H (Illustrated description). Elec Wld-Jan. 18. 1600 w.

*3685. "Past and Present Obstacles in the Storage Battery Development." L. Epstein (A review of the paper on this subject lately presented by Mr. Carl Hering, and claiming that England is far in advance of the United States in the development of the storage battery). Elec Rev, Lond-Jan. 10. 1600 w.

3713. Distribution of Electrical Energy from a Central Station (Abstract of, and comment on, a paper read by William C. L. Eglin at the meeting of the Engineers' Club at Philadelphia. He described in detail the method of distributing electrical energy in large cities). Am Gas Lgt Jour-Jan. 20. 1200 w.

*3714. Motor Care and Repair at Indianapolis. (Scientific testing methods in daily practice—Improvements in armature coils). St Ry Rev-Jan. 15. 3000 w.

*3718. The Booster in Railway Work. J. B. Scott (Largely descriptive of its use in the City and Suburban Railway, of Baltimore, Md). St Ry Rev-Jan. 15. 1600 w.

*3720. The Storage Battery for Street Car Traction (A protest from storage battery people against an article in the September number of this paper). St Ry Rev–Jan. 15. 2200 w.

3727. The Storey Motor or Dynamo (Illustrated description of a machine not only transmitting power in the ordinary way, but specially adapted for direct driving and an enormous range of work). Can Eng–Jan. 1200 w.

*3732. An Electric Pumping Installation. Philip R. Bjorling (Illustrated description of an electric pumping installation which has been working without intermission since 1891). Col. Guard–Jan. 10. 1200 w.

*3760. A Steel Cased Motor (Illustrated description of machines claimed to be practically devoid of external magnetic field, and on this account well adapted to ship work. Test runs are given). Elect'n Jan. 10. 400 w.

3769. The Doushea Method of Charging the Fields of Large Central Station Dynamos (The advantages and disadvantages of the three methods are stated, and the Doushea Method, which is claimed to obviate the difficulties of the three systems, is explained). Elec Eng–Jan. 22. 1000 w.

3782. Arnold Electric Power Station System (Illustrated description of the central station of the Fort Dodge, Ia., Light and Power Company. It is the first plant built according to this system). Elec Wld–Jan. 25. 2000 w.

*3850. Trials of Alternate-Current Plant at Dover Electric Supply Station (Extracts from a report by Profs. A. B. W. Kennedy and S. P. Thompson. The tests had for their main object the determination of the capacity and efficiency of the plant). Elect'n–Jan. 17. 2000 w.

*3853. The Better Utilization of Central Stations. Dr. Rasch in *L'Industrie Electrique* (Favoring the reduction of the tariff for energy consumed by motors). Elec Rev, Lond–Jan. 17. 2000 w.

3864. Electric Elevators, with Detailed Description of Special Types. Frank J. Sprague (Read before the Am. Inst. of Elec. Engs. 5000 in operation in New York city alone. Details of recent machines). Elec Eng–Jan. 29. 8000 w.

*3953. Alternate Current Transformers (Review of a lecture by Dr. J. A. Fleming, the first of four Cantor lectures on this subject). Engng–Jan. 24. 1000 w.

4004. The Calculation of Alternating-Current Transmission Circuits. P. M. Heldt (The article explains in a clear and simple manner the method of calculating the factors to apply in the determination of the size of conductors for alternating circuits). Elec Wld–Feb. 8. 2500 w.

4047. Electric Power Transmission of Niagara. Ill. Orrin E. Dunlap (An account of the rapid progress in the power development). W Elec–Feb. 8. 1800 w.

4049. Central Station Economies. Leland L. Summers (Address delivered before the Northwestern Elec. Assn., Milwaukee. Consideration of the factors which are apt to prove a source of loss). W Elec–Feb. 8. 5000 w.

4050. Are Lower Street Car Fares Practicable? (The past, the present, and the future of electric street railroads is considered at length, arriving at the conclusion that the difficulties are at present insurmountable). Elec–Feb. 5. 2600 w.

4053. Recent Improvements in Storage Batteries. Herbert Lloyd (A paper read before the N. Y. Elec. Soc. The writer having just returned from a tour of inspection of the storage battery plants of Europe). Elec–Feb. 5. 2500 w.

Telephony and Telegraphy.

*3635. The Block Telegraph System. J. Pigg (An examination of some of the weak points of the system). Elec Eng, Lond–Jan. 3. 2000 w.

3639. Centralization of Transmitter Batteries in Telephone Exchanges. Ill. Kempster B. Miller (The advantages derived from such a centralization are set forth and the methods explained). Elec Wld–Jan. 11. 2500 w.

*3650. Automatic Telephone Exchange Systems. Edward P. Thompson, and Ward Decker (The object of this article is to show, in as brief a manner as possible, the operation of each system; but the relative merits of each have not been alluded to further than necessary for a correct description of the same). Elec Pow–Jan. 4400 w.

3672. Field's Compensating Telephone. Ill. (Patent of Stephen D. Field. A mechanical device in the telephone which acts to accentuate or magnify the more rapid and feebler vibrations while diminishing the amplitude of the heavier vibrations). Elec Eng–Jan. 15. 1400 w.

*3759. Electric Tramways and Telephonic Disturbances. C. S. Du Riche Preller (Investigations of the effects of the working of electric tramways in telephones, with a view to determining (1) which of the overhead contact systems is most liable to cause telephonic disturbances, and (2) whether the disturbances, if any, are due to induction, leakage, or to other causes). Elect'n–Jan. 10. 2700 w.

*3761. Cable Communications with South Africa (The connections are given, and an explanation of the recent delays). Elect'n–Jan. 10. 1000 w.

3789. A New Automatic Telephone Exchange System). Illustrated description of the system devised by Mr. Romaine Callender, which is intended to do away with the employment of operators). Eng News–Jan. 23. 1300 w.

3865. The "K R" Law as Applied to Quadruplex Circuits. W. Finn (Data affording an approximate idea of the efficiency limitations imposed by the K R law as applied to quadruplex working in at least one particular case). Elec Eng–Jan. 29. 1500 w.

4009. Portable Telephones. From *N. Y. World* (The system to be installed on the Brooklyn Bridge cars. The invention of Kingsley L. Martin). Lord's Mag–Feb. 2300 w.

Miscellany.

3570. What Electricity Is.—Its Every-Day Applications Clearly Explained (Reproduced from a chapter on "Electricity and Its Future," in a book by Charles H. Cochrane). Bos Jour of Com–Jan. 11. 1800 w.

3576. A Year's Electrical Progress. Charles G. Armstrong (From the *Chicago Record.* Reviews the progress in all the branches of electricity for 1895). W. Elec–Jan. 11. 3400 w.

3577. Consumption of Electricity in Paris. Ill. (Data obtained from the proceedings of the International Society of Electricians, showing rapid growth during the last few years). W. Elec–Jan. 11. 1200 w.

*3580. The True Resistance of the Arc. Silvanus P. Thompson (In reply to claims made by Prof. Ayrton and in criticism of conclusions reached by him). Elec Rev, Lond–Jan. 3. 2400 w.

*3613. Atmospheric Electricity. Arthur Schuster (Delivered before the Royal Inst. of Gt. Britain. A review of early experiments and observations, with explanation of various phenomena). Nature–Jan. 2. 8000 w.

*3633. The Relation between the Atom and the Charge of Electricity Carried by It. J. J. Thompson (Abstract from the *Phil. Mag.* The subject is considered by the writer to be of fundamental importance, and closely related to chemical and electrical phenomena. The first number gives a hydro-dynamical illustration). Elect'n–Jan. 3. Serial. 4800 w.

3638. A Method for the Detection of Weak Dynamo Fields. Buckner Speed (Description of a method used by the writer many times, which has never failed to correctly indicate the weak spool). Elec Wld–Jan. 11. 600 w.

*3648. Electric Arc Welding. William H. Handy (A general review of the practical progress of welding and metal working by electricity, with particular attention to welding by means of the electric arc. Abstracts of the most important articles in the electrical journals are given, together with references to other articles). Elec Pow–Jan. 5000 w.

*3651. A Systematic Treatise on Electrical Measurements. Ill. Herschel C. Parker (The subject is to be treated in a systematic manner and the classification thoroughly worked out). Elec Pow–Jan. Serial. 1st part. 3000 w.

3681. The Electric Manufacture of Aluminum (Illustrated description of process with interesting matter bearing upon the subject). Elec Wld–Jan. 18. 2000 w.

3682. Resonance in Circuits Possessing Self and Mutual Inductance, Resistance and Capacity. A. S. Dunstan (A short sketch of the phenomenon of resonance in simple circuits containing self-inductance, resistance and capacity is given, and the general method of finding the conditions necessary for resonance to occur is shown. The paper is concerned solely with the phenomena of resonance in the primary circuit). Elec Wld–Jan. 18. 1200 w.

3706. A New Electrical Current Rectifier (Consular report from Frankfort, Germany. An invention of Mr. C. Pollak which solves the hitherto stubborn difficulty of converting an alternating into a direct electrical current with a loss of but a trifling percentage of its energy). Eng & Min Jour–Jan 18. 1000 w.

†3722. The Chemical Potential of the Metals. Wilder D. Bancroft (Having in a previous paper communicated the electro-motive force of certain cells, the author, in the present paper, considers the relation between single-liquid polarizable cells and the corresponding constant reversible cells of the Daniell type). Phys Rev–Jan.–Feb. 5400 w.

*3757. Volt and Ampere Meters. J. Warren (The first paper deals with voltmeters. Describes various instruments). Elec, Lond–Jan. 10. Serial. 1st part. 1500 w.

*3762. Device for Protecting Physical Institutes Against Disturbance by Electric Railways. O. Frölich (Abstract of a paper read before the Elektrotechnischer Verein of Berlin). Elect'n–Jan. 10. 2500 w.

3781. Magnetic Properties of Iron and Steel. J. A. Kingdon (From the London *Electrical Review.* The effect of temperature). Elec Wld–Jan. 25. 1200 w.

†3803. The Magnetic Properties of Nickel Steel. Edward P. Buffett (Tests described were undertaken in the hope of attaining a definite conclusion. The general theory involved; apparatus; data and calculations; experiments, etc) Stevens In–Jan. 3200 w.

*3849. Commutatorless Dynamos. Ill. James Whitcher (Criticism of statements in an article by Ricardo Malagoli on "An Alternating Rotary Magnetic Field and its Application"). Elec Eng, Lond–Jan. 17. 1800 w.

*3952. Military Electric Engineers (A proposition that the members of the Institution of Electrical Engineers shall place at the disposal of the government their technical knowledge for the purposes of national defence, and possibly also for offence). Engng–Jan. 24. 2200 w.

*3965. Dr. Hopkinson's Presidential Address to the Institution of Electrical Engineers. Elect'n–Jan. 24. Serial. 1st part. 5000 w.

3981. On the Motions of the Luminous Glow in Rarefied Gases Produced by Electric Oscillations. J. Elster and H. Geitel, in *Wied Annalen* (An account of experiments which give further proof of the nature of cathode rays). Elec Eng–Feb. 5. 1400 w.

3984. The Gross Untrustworthiness of Fuse Metals and Appliances as a Means of Protection for Electric Circuits. The Remedy. Ill. William McDevitt (A paper giving an account of tests made in Philadelphia, and including parts of discussions following papers on this subject, with conclusion suggesting remedy). Elec Eng–Feb. 5. 6000 w.

4005. Unit Systems and Dimensions. T. Proctor Hall (A paper read before the Iowa Acad. of Science. Showing that the C. G.S. system is an arbitrary one, and may therefore naturally give rise to disparities between classes). Elec Wld–Feb. 8. 450 w.

INDUSTRIAL SOCIOLOGY

The Education of the Negro.

IN *American Magazine of Civics* for February, Mr. J. L. M. Curry discusses the meager progress made in the education of the negro element of the southern population, and takes a decidedly pessimistic view of the situation. He evidently regards the negro as an unassimilable element in American civilization, and quotes liberally from other observers to substantiate this position. He presents a rather startling array of facts, and is particularly emphatic in condemning the indiscriminate giving to solicitors for southern educational institutions, placing it in the same category as indiscriminate giving to medicants, which charitable associations are earnestly endeavoring to suppress. The assumed relation of the negro race to other races is strongly lined in the following quotation :

" After the facts, hard, stubborn, unimpeachable, regrettable, which have been given, we may well inquire whether much hasty action has not prevailed in assigning to the negro an educational position which ancient and modern history does not warrant. The partition of the continent of Africa by and among European nations can hardly be ascribed solely to a lust for territorial aggrandizement. The energetic races of the north begin to realize that the tropical countries—the food- and material-producing regions of the earth—cannot, for all time to come, be left to the unprogressive, uncivilized, colored race, deficient in the qualities necessary to the development of the rich resources of the lands they possess. The strong powers seem unwilling to tolerate the wasting of the resources of the most fertile regions through the apparent impossibility, by the race in possession, of acquiring the qualities of efficiency which exist elsewhere. The experiment of the Congo Free State, one of the richest and most valuable tracts in Africa, established and fostered under propitious circumstances by the king of Belgium, seem likely to be a barren failure, and to prove that African colonization is not a practicable scheme without State subvention, or the strong, overmastering hand of some superior race. It requires no superior insight to discover that human evolution has come from the energy, thrift, discipline, social and political efficiency of peoples whose power is not the result of varying circumstances, of the cosmic order of things which we have no power to control.

" The negro occupies an incongruous position in our country. Under military necessity slaves were emancipated, and all true Americans accept the jubilant eulogium of the poet, when he declares our country

> A later Eden planted in the wilds,
> With not an inch of earth within its bounds
> But, if a slave's foot press, it sets him free.

Partisanship and an altruistic sentiment led to favoritism, to civic equality, and to bringing the negroes, for the first time in their history, and without any previous preparation, ' into the rivalry of life on an equal footing of opportunity.' The whole country has suffered in its material development from the hazardous experiment. The south, as a constituent portion of the union, is a diseased limb on the body, is largely uncultivated, neglected, unproductive. Farming, with the low prices of products, yields little remunerative return on labor or on money invested, and, except in narrow localities and where ' trucking ' obtains, is not improving agriculturally, or, if so, too slowly and locally to awaken any hopes of early or great recovery. Crippled, disheartened by the presence of a people not much inferior in numbers, of equal civil rights, and slowly capable of equal mental development, or of taking on the habits of advanced civilization, the whole white people of the south are deprived of any considerable increase of numbers from immigration, and any large demand for small freeholds, and are largely dependent on ignorant, undisciplined, uninventive, inefficient, unambitious labor. Intercourse between the Slavs and the tribes of the Ural-Altaic stock, fusion of ethnic elements, has not resulted in deterioration, but has produced an apparently homogeneous people, possessing a common consciousness. That the two diverse races now in the south can ever perfectly harmonize, while occupying the same territory, no one competent to form an opinion believes."

Business Men and Social Theorists.

Mr. C. R. Henderson, in *The American Journal of Sociology*, treats of differences between the views of the labor question taken by students of sociology and those held by the "captains of industry," by which term he means employers of labor; and he thinks it would be strange if these differences did not exist, and the "captains of industry" did not "sometimes manifest a militant spirit," when the differences in the training, life-work, and general characters of the two classes named are duly considered. "Competitive commercial life is not a flowery bed of ease, but a battle-field where 'the struggle for existence' is defining the industrially 'fittest' to survive.

"In this country the great prizes are not found in congress, in literature, in law, in medicine, but in industry." The successful man is praised and honored for his success. The social reward of business prosperity, in power, praise, and luxury, is so great as to entice men of the highest intellectual faculties. Men of splendid abilities find in the career of a manufacturer or merchant an opportunity for the most intense energy. The very perils of the situation have a fascination for adventurous and inventive spirits. In this fierce, though voiceless, contest a peculiar type of manhood is developed, characterized by vitality, energy, concentration, skill in combining numerous forces for an end, and great foresight into the consequences of social events. If the character is further analyzed, we discover, along with some apparent heedlessness of pain and many compromises with conscience, an integrity about contracts which makes it possible to build the business of the world on credit. Those who live in retirement and simplicity are apt to find the swift, brusque, imperious, and impatient manners of the successful business man somewhat severe and offensively dictatorial. But the ceremonial tediousness of the parlor would be out of place in the office of one who must think rapidly enough to keep thousands of telegraph operators, stenographers, clerks, and other employees in operation. Dainty speech and elaborate politeness under the conditions of life in a great commercial house would have all the effects of crime.

"By extending this study to the psychical processes of typical business men we might be enabled to regard some social phenomena in a new and stronger light. Great business men, like some distinguished generals, let their deeds speak for them. They say, with some touch of contemptuous sarcasm and cynicism, they can hire talkers and buy books. So that to interpret their inner life we must seize the rare occasions when they venture upon speech. As the number of college men among merchants increases, the points of contact with academic men are likely to increase."

As illustrating these differences, a number of passages from speeches of representative business men are quoted. One of these, from an address of Mr. William Whitman, of Boston, is cited as voicing "a certain feeling of his peers." This speech was delivered before assembled representatives of the great commercial clubs at St. Louis.

"Mr. C. D. Wright had suggested that in the future employers would be held responsible before the law at the bar of public opinion for strikes; and that it would be held to be the duty of employers during prosperous times to set aside a fund for the payment of wages in times of adversity. Mr. Whitman declared both propositions to be monstrous, and asked of the gentlemen present: 'What do you think of them? Do you think that this new philanthropo-ethico-economic management will attract the investment of capital? Who are the men engaged in promulgating these so-called reforms, ostensibly for the benefit of workingmen? Are they not, for the most part, theorists with unbalanced minds, who have adopted unsound principles and are pushing them to the extreme? Are they not men without knowledge and experience necessary to deal successfully with men or affairs? Why should men of affairs permit them, undisputed, unanswered, unchallenged, to arrogate to themselves the right to teach the world how we shall conduct our business?'

"This speaker gives his reasons for thinking that business men carry in their own bosoms and interests the guarantees of social welfare. 'The purposes of business, the sense of responsibility to others, the danger of personal loss and possible failure, and the hope of reward are the surest guarantees for the conduct of affairs in the mutual interests of employer and employed.'"

Notwithstanding that the force of these views, regarded as typical expressions of those held by the "captains of industry," is fully admitted, Mr. Henderson is not prepared to admit that "the student of society is without a function, a mere useless parasite, or, at best, a phonographic reporter of the dead past." He thinks "it is the duty of the scholar to place and keep before the public the supreme criterion of social conduct, the common welfare," which is apt to be but dimly recognized in the uproar of business, even if it be not altogether obscured.

"These quotations prove that many essential elements are ignored by very able and upright men. They imply that there is at least one class of the community who have no interest in the issue of social strifes, and no right to be heard on their own behalf. They imply that economic forces are automatic, natural, and not human and ethical. The influences which fix the rate of wages are treated as if they belonged to the same category as the law of gravitation. Human intelligence, will, and aspiration are excluded from consideration by such logic. Economics is put on the same level as biology, or even chemistry. The corrective of this attitude of some practical men is not abuse, but facts, —just such facts as the studies of social history supply in abundance. It is the duty and function of the theorist to confront this automatic and fatalistic class theory of business with the history of factory legislation. . . . The social position of the 'social theorist' is an advantage. The nature of his studies compels him to come into touch with persons of all classes and interests. He hears and reads on all sides. His associations are with the refined, and his ideals of life are formed in the best company. But his professional pursuits compel him to weigh the claims of the entire community."

Rural Loan Associations in Germany.

THE following is an abstract of a consular report for December, which gives interesting details.

Herr Raiffeisen, mayor of Flammersfeld, about the end of the year 1848, had the care of thirteen parishes, with a population of about five thousand. Many well-to-do land owners in this population were in the clutches of local money-lenders, who ruled the community. With much difficulty Raiffeisen succeeded in getting all the members of the parish of Flammersfeld to join together and form, in common, an unlimited-liability society, and thus the first rural company for lending money out on interest (*Dahrlehnskassen-Verein*) was founded. The system worked so well that, at the end of ten years, all the small peasants who had hitherto been a booty for the money-lenders became free men. Then it was that a commission was sent from Berlin to study the system of forming coöperative associations for lending money.

The strength of the Raiffeisen associations consists in unlimited liability. No member can escape, for the association is not responsible for any of its members, but merely for the sums of money deposited. Their safety is so trusted that bankers have declared themselves ready to grant the associations credit, merely on the ground of their unlimited responsibility and without asking for any other guaranty.

In an association of some fifty-eight members, the community being in prosperous circumstances, each member can safely be calculated to be worth 10,000 marks ($2,400). Thus the society can be said to dispose of a capital of 580,000 marks ($140,000). As the directors of the associations are not allowed to speculate in any way, and are empowered to lend money only to members, a complete security is offered.

Servants residing in places where there are no Raiffeisen Vereine frequently place their savings in the nearest associations, and *Pfennigsparkassen* have been instituted, where savings of ten pfennigs are accepted on deposit from children.

Any one desiring a loan is obliged to proceed as follows: (1) he must at an early date apply either to the director or to the accountant of the association; (2) he must explain for what purpose he requires the money; (3) how much *he can pay back yearly*; (4) somebody with whom he is on friendly terms must "go security" for him. The third point is a standing rule of the associations. However, respites are granted, and the return of payments may be made during the year in the smallest sums. In any case where the accountant or directors divulge anything with reference to a credit which has been promised and vouched for, a fine of 30 marks ($7.50) is imposed on them.

As those who have become sureties for their friends are responsible, it is for their interest to see that the loan obtained is used for the purpose given out, and, if not, to notify the association, and thus shield themselves. Where both the borrower and he who answers for him meet with heavy losses through no fault of their own, the association is empowered to cover the deficit resulting from the reserve fund. This, however, is most rare.

The various Raiffeisen societies are in the habit of laying in a stock of different articles, such as artificial manures, fodder, fuel, and flour.

After the second or third year the associations generally begin to accumulate cash surpluses. The loans draw 3½ per cent. interest. When the borrower obtains his loan, he pays ½ per cent., which goes into a fund called "provision." The gains are divided each year into three funds: (*a*) indivisible fund, (*b*) a reserve fund, (*c*) a fund out of which dividends are made to members. Losses are paid out of the reserve fund. The indivisible fund is varied according to yearly requirements. Thus the associations make a gain of ½ per cent. Another species of association is the *Schulze-Delitzsch*, or credit, association, which affords means for purchasing materials or borrowing money. Associations of this type are speculative. They operate without limitations, and the gains are divided in a ratio corresponding to the magnitude of members' shares. The basis of their operations is not so safe as that of the Raiffeisen Vereine, and a number of them have been wound up in consequence of over-speculation. In 1893 there were 1038 societies on the Schulze-Delitzsch system, with a credit estimated at 1,579,000,000 marks ($393,000,000). There were also 713 of the Raiffeisen Vereine, with a credit business of 25,000,000 marks ($6,000,000).

There is also the Bavarian *Landesverbande*, and the Genossenschafts-Kassen, which last require no profits and pay no dividends. The only salaried member is the cashier, the different members of the board acting in a purely honorary capacity. As a result, they are in a position to offer a fair interest to their creditors, and exact a modest rate of interest from debtors.

Municipal Ownership.

THE extension of this system to electric light plants is handled without gloves by Mr. John A. Britton in a letter recently sent to the board of trustees of the city of Alameda, Cal. Incidentally the extension of the system to other industries, as has recently been the tendency in many cities, is severely reprobated. We shall, in this review of Mr. Britton's letter (published in *American Gas Light Journal*, Jan. 20), attempt to present some of the stronger arguments against the further extension of municipal ownership.

"It is a usual thing for any municipality to invite and encourage any business which may bring to it capital and the employment of labor, and an action of any government which would drive from its midst such capital and such employment of labor is certainly to be deprecated. The engagement by municipalities in industries would tend to the throwing out and breaking down of any attempt on the part of capital to interest itself in the building up of a city.

"The protection of capital and the protection of labor are duties of governmental bodies far above and beyond that of any other sphere in which they may work. The destruction of capital means the destruction of labor. The protection of capital means the protection of labor. One is as much dependent upon the other as the life of plants is dependent upon the sunshine.

"If it can be reasonably demonstrated that municipal capital, wrested from the property owner and which has been acquired by him through his own exertions and toil, can be used again to his benefit, then no argument can offset it; but if, on the other hand, it can be proven, as I hope to prove, that the wrestings of the earnings of labor are to be used by political bodies for a thing which cannot result in benefit to the average taxpayer and landholder, then I say, and say positively, that no board of trustees, council, or board of supervisors controlling any district has a moral or a legal right to take that money and use it for the benefit of the few to the detriment of the many.

"Regarding municipally-conducted electric-light plants, Mr. Britton asserts that the truth with reference to their maintenance and operation has never been stated, and misrepresentations by interested employees have formed the basis of statements made to the general public. Citing the municipal electric-lighting plant of Alameda he compares it to 'a man with an income of one hundred dollars per month living upon one hundred and fifty dollars. Somebody pays for the excess of expense over receipts. If it were a clerk in commercial circles, his employer would pay for it in a surreptitious manner. In municipal circles it is the taxpayer who submits to the extra burden.'

"From reports filed by city officials, he finds that the cost of lighting the city for six years and five months has aggregated the sum of $155,223.74,—an average of $2,016.27 per month. The average number of lamps maintained for public lighting during that time, according to the report of the city electrician, has been 88. This gives an average cost per lamp per month of $22.90. According to the schedule of lighting (which is a lighting from dark until 1.30 A. M., excepting on nights when the moon is shining, and which time amounts to 117 hours per lamp per month), the average cost per lamp per hour is 19½ cents.

"I am aware that the contention will be made that it is not fair to calculate the entire cost of the plant as a basis of the cost of operation; but I submit that in a municipal plant no other basis can reasonably be employed. The cost of the operation of any municipal enterprise the taxpayers have to make up to the city in their annual payments."

Deducting present worth of plant from the total expenditure for electric lighting during the seventy-seven months in which the system has been operated, he finds that the cost has been 15 cents per lamp-hour. He then compares this cost with the cost per lamp-hour, in Oakland, Cal., where, under the management of a private corporation, it is only 6.43 cents per lamp-hour.

Assuming all construction work to stop, that no alterations will be needed, and that the expenses will remain as figured by interested employees, Mr. Britton arrives at the conclusion that even under such inconceivable conditions, the cost of lighting the streets will exceed by 75 per cent. the cost of street-lighting in any other city in the United States. If the facts are as stated by Mr. Britton, and if his calculations are correct, surely Alameda furnishes an emphatic and instructive lesson of the folly of extending municipal ownership.

Labor and Wages in China.

T. R. JERNIGAN, consul general at Shanghai, in *Consular Reports* for January, gives an interesting account of the status of labor and wages in China,—a country in which, among other peculiarities, the lowest wages are paid to labor, and the supply of labor is larger in proportion to the demand, than in any other country on the face of the globe. Any one endeavoring to study the limitations of that much-abused term, "necessaries of life," or desiring to solve the problem of the least cost of existence for a human being, may find aid in this paper, of which an abstract follows.

A Chinese laborer will save money on wages that would hardly be sufficient to supply the absolute necessities of an American laborer. This is made possible by the cheapness of the vegetable diet on which he is content to live, the small cost of house accommodations (several families will subdivide one room of a house, and live in contentment in it), and the low price paid for clothing, which is made of the coarsest cottons. But the cheapness of labor in China does not mean that the products of that labor are inferior in quality. The Japanese laborer, receiving higher wages, is more artistic in his work; his productions are finished, and in dyes and in the blending of colors he is superior to his Chinese rival; but in substantial and lasting quality the latter's products are fully equal, and in some instances superior, to those of the former.

There is in Chinese character a conservatism which has discouraged progress. The principle, "let well enough alone," has been adhered to under the mistaken idea that "well enough" was the best. But in China this adherence to custom, this opposition to change, has filled the empire with an impoverished population; for a people that use in their trade and business a currency of so small a denomination as one-tenth of a Mexican cent cannot be said to have felt the quickening influence of an enlarged and civilizing commerce. The cheapness and small denominations of Chinese currency, and the low price of the diet and clothing of the Chinese laborer, are evidence of non-progressiveness, but it should not be inferred from these that capacity for progress is absent from the Chinese character.

The following wages for different handicrafts in China are quoted. The symbol, F, indicates that, in addition to money, food is supplied as part of the wage. Where this is absent, no food is supplied, The wages are presented in their equivalent of United States currency.

Blacksmith, 13 cents per day (F); brass-worker, 16 cents per day (F); barber, 3 cents per day (F); native bootmaker, 10 cents per day (F); foreign bootmaker, $5.28 per month (F); bamboo cabinet-maker, 11 cents per day (F); bricklayer, 10 cents per day (F); native compositor, $5.28 per month (F); foreign compositor. $7.92 to $15.84 per month (F); carpenter, 11 cents per day (F); cabinetmaker, 13 cents per day (F); coolie, 13 cents per day; native bookbinder, $4.22 per month (F); foreign bookbinder, $6.34; lithographer, $10.56; furniture polisher, 21 cents (F); native tailor, 10 cents per day (F); foreign tailor, $6.34 per month (F); pressman, $6.34 (F); native coachman, $3.17 per month (F); foreign coachman $6.34 per month (F); native house-boy, $2.11 per month (F); foreign house-boy, $4.75 (F); cotton-mill machinist, 11 cents to 22 cents per day; cotton-factory hands, 18 cents per day.

It will be seen that the practice of making food a part of compensation for labor is common; that foreign labor, without exception, gets better pay than native labor; and that foreign compositors get higher pay than laborers in any of the other occupations named. The lowest daily wages are paid to barbers, and the lowest monthly wages to native house-boys.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

†3598. German Interests in Eastern Asia. Theo. M. Stephan (Statistics of exports and imports). Consular Reports-Jan. 700 w.

†3599. European Sewing Thread in China (Extract from a report of the Austro-Hungarian consul-general, of interest to American manufac-

turers of sewing threads). Consular Reports–Jan. 1500 w.

†3600. The Four New Treaty Ports of China (The ports described are Chungking, Hangchow, Soochow, and Sha tsze. Brief mention is also made of the Yangtze Gorges, 60 miles above Sha-tsze). Consular Reports–Jan. 2600 w.

†3601. Labor and Wages in China (The lowest wages paid in any known country prevail in China. The labor supply is also more abundant than in any other land. Notwithstanding this, in utility and lasting qualities, Chinese manufactures take a high rank. The causes of these peculiarities are interestingly discussed). Consular Reports–Jan. 1500 w.

3616. Movement of Prices (A review of prices from the close of 1890 to the beginning of 1896, including an important table of comparative prices of 109 staple articles, raw and manufactured products, produce, cattle and meats, at quarterly intervals, showing fluctuations in quotations from the close of 1890 to Jan. 1, 1896, covering the period of recent extreme depression). Bradstreet's–Jan. 11. 1800 w.

3712. Municipal Ownership of Electric Light Plants. John A. Britton (A powerful argument against the moral and legal right to wrest the property of electric light plants, or other analogous property from their present ownership, and claiming that in the case of electric light plants, the maintenance would be increased 75% under municipal control). Am Gas Lgt Jour–Jan. 20. 4800 w.

†3724. Business Men and Social Theorists. C. R. Henderson (The great prizes in this country are not found in Congress, literature, law or medicine, but in business. The peculiar type of manhood developed by this condition is the principal theme of this paper). Am Jour of Soc–Jan. 5000 w.

†3725. The Province of Sociology. George E. Vincent (Syllabus of a course occupying four hours per week during twelve weeks: given by the author at the University of Chicago in the autumn quarter, 1895). Am Jour of Soc–Jan. 6400 w.

*3798. In the Cause of Good Government (Editorial review of an able address delivered by the rector of the Edinburgh University, which enforces the duty of practical politics upon every member of society who desires the reform of social relations, especially those relating to industrial activities). Jour Gas Lgt–Jan. 14. 2000 w.

3805. A Unique Statistical Experiment (The preparation of this article, and the tabulated statement accompanying it, have involved an enormous amount of labor. It is an analysis of the correctness of business ratings, according to the system of the Bradstreet Co., the basis being the records of success or failure of those thus rated through a considerable period. Many valuable lessons in industrial sociology may be derived from a study of these statistics and in connection with the financial history of the period covered). Bradstreet's–Jan. 25. 5000 w.

*3815. The Industrial Condition of the South before 1860. Richard H. Edmonds (Historical review with statements tending to prove that the industrial condition of the south has been misrepresented, and that previous to the war it was quite abreast with the times). Chau–Feb. 5000 w.

*3840. Our Monetary Programme. J. Laurence Laughlin (The writer holds that the cause of all our monetary disturbances is not one connected with the medium of exchange, but one concerning the maintenance of a definite measure in which prices and contracts are expressed). Forum–Feb. 7000 w.

†3843. Why Gold Goes Abroad. A. C. Fisk (The writer finds an answer to the question in an examination and analysis of the government reports of exports and imports. He finds the remedy in a silver basis, or one-hundred cent dollar basis). New Sci Rev–Jan. 2500 w.

*3845. Customs Tariff of New Zealand (Table of duties now in force since the revision under an act passed Oct. 18, 1895). Bd of Tr Jour–Jan. Serial. 1st part. 1200 w.

*3846. Tariff Changes and Customs Regulations (Includes changes in tariffs and customs regulations throughout the world). Bd of Tr Jour–Jan. 6000 w.

*3847. New Currency in Porto Rico (Circulation of Mexican dollars forbidden. A special coinage will be issued under Royal Decree, with authorized circulation in Spain). Bd of Tr Jour–Jan. 500 w.

*3860. Tariff Reductions and Fiat Money. Raymond E. Dodge (An argument in favor of establishing a United States Bank, and the extinction of fiat money; the position being taken that the latter is attended with dangers that can only be guarded against by the establishment of the former). Gunton's Mag–Feb. 2400 w.

*3861. The American Federation of Labor (Editorial review of the proceedings of the fifteenth annual convention of this organization, held in New York Dec. 9 to 17, 1895. It is regarded as the leading radical society on this hemisphere, and as having a great future before it). Gunton's Mag–Feb. 1300 w.

*3862. Compulsory Arbitration. Jerome Dowd (A socialistic argument for more extended state control of labor; the state to fix wages in many employments, and to forbid workmen quitting their work at their own option. State regulation of prices and rates of transportation are also advocated to an extent rendering the individual nothing, and the state everything). Gunton's Mag–Feb. 2200 w.

†3913. The Increased Production of Gold. Edward Atkinson (Differences in conditions under which our modern supply of gold are obtained as compared with former years are noted, and an effort to present data for a forecast of the effect of the great annual additions to the world's stock of gold is essayed. The argument is based upon the assumption that the world's commercial unit of value is now fully and finally established, and that it is a fixed weight of gold, whether in ingots or coins made from ingots. The position is also taken that the United States holds command over all the gold resources of the world, and the dominant control of iron, steel

and copper. The demand debt of the United States should be paid without forced loans, and legal tender notes paid in coin should not be reissued). N. Amer Rev–Feb. 5500 w.

*3925. Shall the American Home Be Saved? William S Beard (An examination of the question whether or not the American nation is on the upward trend, based on the condition of the unit of nationality, the family; this condition being determined from available evidence. The conclusion is reached that the condition of American homes is on the average, deteriorating and is approaching a destitution of general well-being; and that hence the ravages of civil decay have already begun in American institutions). Am Mag of Civ–Feb. 5200 w.

*3926. Proportional Representation: A Remedy for Municipal Misrule. J. Eugene Whitney (Paper presented at meeting of New York State Commissioners on City charters. The thesis is that while in theory our government, municipal, state and national, is founded upon a representative system, it is not so in fact, and the argument is directed to the support of this proposition. Glaring evils of our system in its practical operation are noted. Unless proportional representation in fact as well as in theory be restored, these evils will persist and increase). Am Mag of Civ–Feb. 2300 w.

*3927. The Labor Problem. Nelson Baldwin (The first part discusses the growing evil of tramps, and traces it to want of sufficient employment to keep available labor busy. Labor's share of the products of labor is considered as too small. The question of how demand for labor can be increased is also discussed, and monopoly is charged with being the greatest enemy of labor). Am Mag of Civ–Feb. Serial. 1st part. 3200 w.

*3928. The Silver Question, Jay Cooke, in the *Investment News* (The act of 1873, demonetizing silver, is held to have been ignorantly legislated, and ignorantly signed by the president. Its results are held to have been disastrous. The silver question is treated as of supreme importance to the United States, and the salvation of the country is regarded as conditioned upon a return to bimetallism). Am Mag of Civ–Feb. 2200 w.

*3930. The Ethics of Trade and Capital as Related to Popular Government. David Allyn Gorton (The evils resulitng from inequality and which have cursed the old world, are held to be developing in the new. The paper is an argument and protest against this inequality. Capital and labor are regarded as warring against each other. The growing need of a standing army to keep peace between the rich and the poor, is one of the rather ultra assertions made by the writer). Am Mag of Civ–Feb. 4500 w.

*3931. The Education of the Negro. J. L. M. Curry (The process of educating the negro element of our population is of necessity slow, but the progress so far made, if it can be called progress at all, is so meagre that the author evidently does not hope for much ultimate improvement in the Afro-American status). Am Mag of Civ–Feb. 5000 w.

*3936. Some Leading Errors of the Gold Standard Party. Otto Arendt. Translated by E. Benj. Andrews (This article first appeared in the *Deutcher Wochenblatt*. Though primarily intended to refute certain views put forward in the *Silesian Times*, it is of general interest. It is a strong argument favoring bimetallism). Rev of Rev–Feb. 3500 w.

*3937. Bimetallism: Some Damaging Facts in Its History. Frank Irving Herriott (Review of the History of Currency, by Mr. W. A. Shaw, and Money and Banking, by Horace White, of the New York *Evening Post*). Rev of Rev–Feb. 3000 w.

4007. Proposed Changes in the Patent Laws (Editorial. An able and just criticism of some of the proposed changes in the United States patent laws now under consideration by the House Committee on Patents. Lurking dangers are pointed out, particularly the clause of the bill providing for the termination of a patent by act of Congress). Ir Age–Feb. 6. 1800 w.

4033. Wealth and Finance Statistics for a Century (Statistics compiled from the last bulletin of the Department of Labor). Bradstreet's–Feb. 8. 1400 w.

4034. Reforming Speculation in Grain (The new so called Lindblom plan, named from its originater, explained, and a scheme for its organization set forth. Under this plan sales are to be followed by immediate delivery, which, it is assumed, will exterminate bucket shops. The present prospect is that this plan will be adopted, and that an anti-option bill will follow in due time). Bradstreet's–Feb. 8. 1100 w.

4035. The Silver Senate (The supremacy of the silver men in the United States Senate is considered as demonstrated by recent legislation, but its mischievous effects are likely to be warded off so long as present conditions remain at the seat of government. The non-concurrence of the House and the antagonism of the President will, for the present, at least, be efficient obstacles to action of the Senate). Bradstreet's–Feb. 8. 700 w.

4040. Capital and Labor. R. H. Hadfield (Results of experience in an extensive English steel works. The effort to get employers and employed on a better footing is urged as a possible solution of many differences between them). Eng & Min Jour–Feb. 8. 2200 w.

†4065. Infantile Life Insurance in Europe. C. W. Chancellor (The system, at the present time forcing itself upon the American public, is disapproved, having shown itself in Europe to hold out inducements among the evil minded to parental neglect, cruelty, and even crime). San–Feb. 2000 w.

*4078. Our Unused Surplus. Charles H. Smith (From an address delivered before the annual meeting of the Mich. State Millers' Assn. Discusses obstacles to increased foreign demand for American flour and urges the putting aside of partisan prejudices and a common effort directed to the extension of our foreign trade not only in flour but in other lines of manufacture). Am Miller–Feb. 2000 w.

MARINE ENGINEERING

Shipping on the Great American Lakes.

AMONG the mass of information relating to the marine traffic on the North American lakes, presented in interesting form by Mr. Henry S. Pickards, in *Yale Scientific Monthly* for February, we single out for this review the topic of naval construction. The progress made in western shipbuilding is beginning to attract the serious attention of shipbuilders at other points, and even in England, where ships have been turned out at lower cost than in any other land. The possible development of a shipbuilding industry on the shores of the American lakes that will successfully compete with, and become a powerful rival of, English marine engineering and construction has already excited apprehension in Great Britain. In the industry as it now stands, Cleveland, Ohio, seems to be taking the lead. Mr. Pickards says that "some of the largest and finest of the lake carriers are built in Cleveland, at which port are built ships aggregating greater tonnage than any other port in the world. The modern lake carrier is not surpassed, except in size, by anything afloat. The two passenger steamers built in 1895 by the Globe Iron Works Co., of Cleveland, for the Northern Steamship Co., are as fine in construction and equipment as any ocean ship. As floating hotels, they rival the great trans-Atlantic liners. They are each three hundred and eighty-five feet long and capable of a speed of twenty miles per hour. Schedule time is made between Buffalo and Duluth in connection with the Great Northern Railroad.

"The peculiar conditions existing on the lakes, due to shallow passages and bulk freight, has brought out much ingenuity in the construction of ships. The Whaleback—or pig, as it is more familiarly called from its peculiar appearance—is distinctly a lake type of vessel, although a few ships of this model have been taken to salt water. It was invented by Capt. Alex. McDougall, and many ships of this class have been built by the American Steel Barge Co. at West Superior, Wis. For carrying capacity on a limited draught, and economy of construction and operation, they are very successful. The monitor is a type of ship following somewhat the lines of the 'whaleback,' and possessing some of its advantages.

"The straight-back is another style of construction coming into favor. It is not very different from the ordinary lake steamer, except that, as the name implies, it has a straight back having no sheer whatever, which somewhat cheapens the cost of construction.

"But most of the freight is still carried in the ordinary steamer, whose principal point of difference from an ocean ship lies in the position of the engines, which are placed well aft, affording greater facility for loading and unloading. Several large ships have lately been built on the ocean model with the engines amidships, which keeps the bow down, and improves the steering qualities in a head wind, when the ship is light. As most of the large carriers prefer to go light from the lower lakes to the ore-shipping ports, rather than to carry coal and be detained by the loading and unloading, this is an important consideration. However, this type of ship has found little favor on the lakes, and few of them have been built.

"The tow barge also plays an important part in lake commerce. In former years it was not uncommon to see a steamer towing four or five old schooners up the lakes at a rate of five or six miles an hour. Then the new steamers found that much better time could be made by running alone, and for a time the tow barge seemed to fall into disfavor, only the poorest class of ships being found in this service. The introduction of the 'whaleback,' however, and the economy with which a fleet of steamers and two or three barges could be operated, and the large cargoes which they accommodated, caused a revival of towing, and now many large steel schooners are coming into use, and are towed by some of the largest and fastest of the lake freighters.

"In this same line comes an entirely new departure, which is the result of the enterprise of the Cleveland Steel Canal Boat Company, which has built and put into operation a fleet of canal boats of such type that they are amply large and strong to navigate Lake Erie in good weather, and also of such size that they are able to pass through the Erie canal. They are thus able to load freight on the lower lakes and deliver it in New York without breaking bulk, and to bring sugar and other slow freight back under the same conditions. This has a tendency to remove the center of eastward canal shipment from Buffalo, and to distribute it among the other Lake Erie ports. The large steel plant at Lorain, Ohio, has shipped one large consignment of steel rails to New York by this route. The success of this venture is amply proven by the fact that the company has placed an order for three steamers and ten barges, which will increase the capacity of the fleet three fold. The building of these boats on salt water, at the end of the route, indicates no dissatisfaction with those already built, but that the yards on the lakes are so busy that there was doubt as to the time when they would be ready for service, and also that the company desired to have one fleet ready to start from each end of the line at the opening of navigation, the present fleet having been laid up on the lakes." This rush in the lake ship-yards is in strong contrast with the recent stagnation in ship-yards abroad.

The Submarine Boat "Le Goubet," No. 2.

WE herewith present an abstract of an illustrated description of this, one of the most successful submarine boats yet produced (reprinted from *La Nature* in *Electrical Review* of Jan. 10).

The shape of the boat is that of a spindle formed by the revolution of an arc turning on its chord. The regularity of its outline is interrupted at the top by a dome or oval lid which opens to give access to the interior, and at the bottom by a kind of false keel which, while imparting exceptional stability to the apparatus, constitutes a safeguard in cases of unforeseen emergency. Upon one turn of a key being given by one of the staff, this weight is detached, leaving the floating part, thus suddenly lightened, to rise to the surface of the water like a cork.

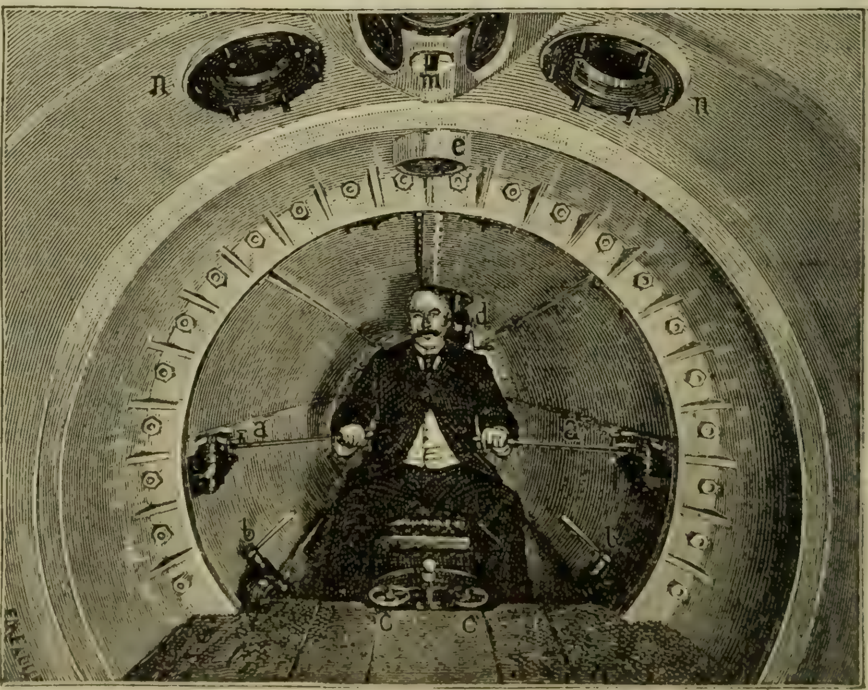


FIG. 1.

In the horizontal middle plane two thin wings run from end to end of the boat, contracting the rolling movement, and serving as a support to the self-propelled torpedoes which the boat carries when required. The port holes are distributed at equal height along the shell, and on the top of the dome. "Le Goubet" No. 2 measures 8 meters in length, and has a diameter of 1.75 meters at the row-locks. It weighs about 10 tons, and it can be taken apart into three pieces, which are held together by inner collars securely bolted. The false keel alone weighs 1,200 kilograms.

Whereas in the first boat there was a little want of space, the two men forming the crew being obliged to sit back to back just in the axis of the ship, the new type is more roomy in the middle; the captain can take his place on a revolving seat, which enables him to look out through the port-holes in the dome, and the two sailors who assist him are seated at the two extremities, opposite one another, each having within reach the controlling appliances required for his work.

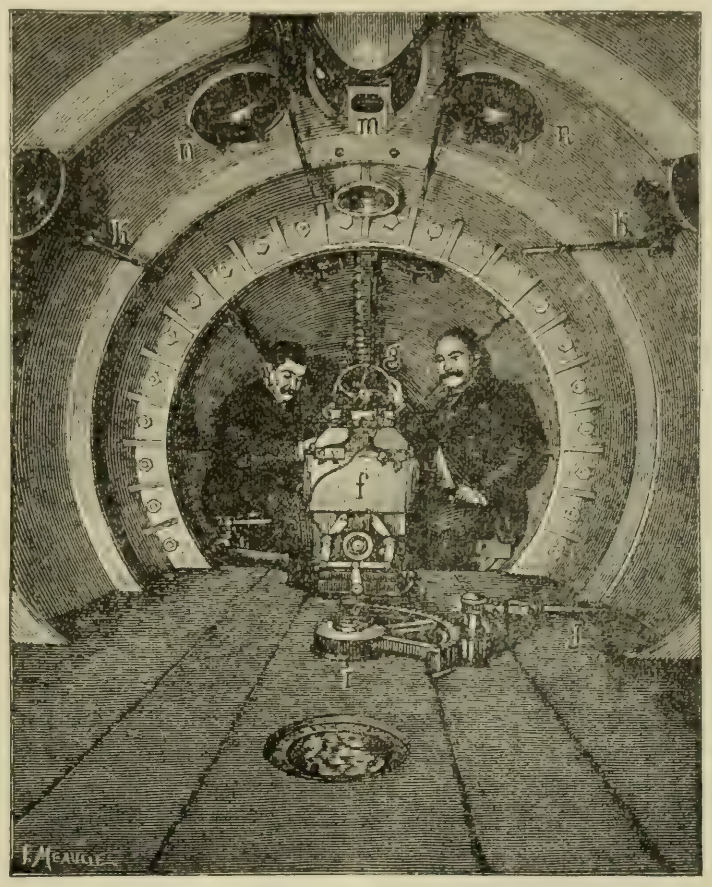


FIG. 2.

The man who works the oars (Fig. 1) has in front of him the handles, *a*, *a*, a fact which enables him to open upon the sea the outlet of the pump, the taps of which are *b*, *b*, and to expel (as required, and according to the position of the valves, the wheels of which are seen at *c*, *c*,) the water, which serves as ballast, or the vitiated air, which, owing to the density of the carbonic acid, is condensed in the bottom of the boat. Behind his head, at *d*, is the "postal" apparatus, the cavity of which may be either opened for the placing in it of the little water-tight case containing despatches, or put in communication with a vertical chimney opening into the sea when the case rises to the surface of the water by its own specific lightness. The fore-part of the vessel also contains the steel tubes, holding the reserve stock of respirable air.

The electromotor is in the stern (Fig. 2). On the inner sides of the shell are bolts for setting free torpedoes, shown in the same figure. On the floor (Fig. 2) is shown the handle which gives a quarter of a turn to a bayonet hinge that keeps the false keel in position; this quarter of a turn is sufficient to detach this safeguard, and thus set free the floating part, which at once rises to the surface.

In the normal state the little vessel floats on the surface of the water, only the dome appearing above. The captain, by looking through the port-holes that are out of the water, can sweep the horizon and steer at his ease. It is very difficult to perceive from a distance this floating part, which is no bigger than a life-buoy. Only when it enters the zone of danger does the real work of the submarine vessel begin. A little water being introduced into the bottom of the vessel, it is submerged to the required depth (4 or 5 meters generally; 10 meters, if necessary).

When it is thus submerged, objects above water are seen by means of an optical tube passed through the bronze shell and reaching to the surface. Ingenious arrangement of water ballast enables the boat to keep at the desired depth of submergence. The motive power is supplied by a bisulphate of mercury battery, without use of accumulators. A speed of from four to five knots per hour is said to be easily realizable.

Care of Marine Boilers.

THE care of the modern marine boiler is discussed by F. W. Kincaidy, passed assistant engineer U. S. N., in *American Machinist* (Feb. 6). The advantages of heating feed-water by heat derived from the uptake, and of maintaining a supply of fresh water through the use of evaporators, are urged. The advantage of heating feed-water, even when the heat of the uptake is not utilized for this purpose, has generally been conceded. Its effect upon the durability of marine boilers is marked, and the cost of repairs due to leakage, etc., is lessened. Engineers are apt to neglect evaporators, and, on thewhole, the supply of fresh water is not of so great importance as properly heatingthe feed water.

" As a matter of fact, even when evaporators are fitted to ships, their existence is often ignored by the chief engineer, who is apt to look upon these things as unmitigated nuisances. If he wants to make up feed, he uses salt feed ; and, it must be confessed, if his internal feed-pipes are properly arranged, there is no harmful result. If the feed-water, after passing the check valve, is led through, say, twenty feet of internal piping, and then allowed to mingle with the surface water of the boiler, we have then an arrangement which constitutes the boiler its own feed-heater. The sulphate of lime is precipitated in the body of the water (whose temperature, with steam of 160 pounds' pressure, is about 371 degrees F.) before it has time to reach any of the heating surfaces, and the result is a boiler free from leaks and scale, and absolutely clean, with the exception of a little mud in the bottom, which can be blown out.

" Live steam heaters, with removable pans for catching the scale, are sometimes fitted over marine boilers, the heated and purified feed entering the boiler bygravity. Such an arrangement is to be recommended in the case of water-tube boilers, where it is inconvenient or impossible to fit internal feed-pipes."

The Engineers' Strike at Belfast and on the Clyde.

ENGINEERING (London, Feb. 7) says that the great lock-out, and strike at Belfast and on the Clyde has ended, and the men, as far as practicable, have resumed work. It naturally takes a little time to settle down, each in his own place, after a stoppage extending over months, but it appears that the resumption of work has been as general as could have been expected. In Belfast there were the further difficulties with the ironfounders, and with the brassfounders and brass-workers, but these seem also to have been arranged. The question of the apprentices also had caused some friction, but the matter has been arranged. Some inconsiderate persons have been calling in question the right of the council of the Engineers to bring pressure to bear upon their Belfast members to induce them to return to work. The council may be left to justify their own action as regards the technicalities of their rules, but on general grounds the council of a society have always exercised pressure when circumstances indicated the necessity. And, as a rule, the society generally has supported such action, in spite of severe condemnation on the part of a small but noisy clique. Instances could be cited in which the engineers, boilermakers and iron ship builders, carpenters and joiners, ironfounders, and others, have exercised such pressure with advantage. The council is not likely to interfere recklessly. The question is one needing the most tactful and considerate treatment, and before touching it, great caution will doubtless be exercised.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*3594. Water-Tube Boilers. J. D'Allest (Criticism of a communication to *Engineering*, by Messrs. Maudslay, Sons and Field, called out by a paper of John K. Robison, U. S. N., purporting to give conclusions derived from personal observations of water-tube boilers in the French Marine). Engng-Jan. 3. 1800 w.

*3595. Sir Edward J. Harland (Obituary

Gives an account of the life and work of one of the most famous English naval architects). Engng-Jan. 3. 6700 w.

†3602. The Port of Shanghai and China's Trade (Details the companies and vessels which trade at this important port and predicts that the future route to China, either with or without the Nicaragua Canal, will be across the Pacific). Consular Reports-Jan. 2200 w.

*3658. List of Vessels Launched in 1895 (Purports to be a complete list of new vessels set afloat from all yards in the world during 1895, with names of owners, material of construction (steel, wood, etc.) class names of the vessels, and nominal horse-power). Marine Eng-Jan. 1. 15000 w.

*3659. Summary of Shipbuilding Returns of United Kingdom in 1895, Arranged in Order of Tonnage, Built by Each Firm (A useful table for reference. Seventy establishments are listed). Marine Eng-Jan. 1. 300 w.

3666. Present Strength of the New United States Navy (A list of the United States warships with brief descriptions, and two page illustrations, showing comparative dimensions of forty of them). Sci Am Sup-Jan. 18. 2000 w.

*3684. The Submarine Boat "La Goubet." From *La Nature*. G. E. (Illustrated description of a torpedo boat, named for the inventor). Elec Rev, Lond-Jan. 10. 2000 w.

*3735. The Stranding of French Ironclads (Full account of the grounding of the Formidable and two other ships of the French navy, the cause of the accident and their rapid and skillful extrication from a perilous position, with a picture and a map of the harbor of Badines, where the incident occurred). Engng-Jan. 10. 4000 w.

*3754. Submarine Navigation. John P. Holland (Abstract from a lecture delivered before students of Sibley College. An able and exhaustive discussion of the principles of submarine navigation and construction, showing very plainly the differences between these principles and those applicable to floating vessels, whence arise many difficulties which have been gradually surmounted in the progress of the art. An exceedingly interesting paper). Sib Jour of Engng-Jan. 6500 w.

*3827. Naval Architecture—A Few Principles Popularly Explained (First part deals with displacement, illustrating the text by diagrams, and employing only simple equations of the first degree). Eng, Lond-Jan. 17. Serial. 1st part. 2200 w.

*3836. Transatlantic Navigation. R. C. Lanphier (Historical. Beginning with the earliest attempts of steam propulsion, the account is brought down to date). Yale Sci M-Jan. 6500 w.

*3837. Recent Developments in Torpedo Boat Construction. F. S. North (Deals with modern torpedo boats, their operations in the late China-Japanese war, their requirements, etc.). Yale Sci M-Jan. 1600 w.

3858. The Timber Dry Dock No. 3 at the New York Navy Yard (Popular description with views of the work in progress). Sci Am-Feb. 1. 1100 w.

3874. A Condensed Engine. Ill. (A remarkable and curious steam engine design by Mr. Frank Cary, Penn Yan, N. Y., with low centre of gravity and singular compactness). Am Mach-Jan. 30. 800 w.

†3915. The Mysterious Wreck of Nemi. Rodolpho Lanciani (Describes the discovery and the attempts at lifting the wreck of a large ancient vessel. Such portions as have been recovered show a knowledge of the art of naval architecture, dating back to the classic period of Roman history, very much in advance of what has been commonly supposed). N Amer Rev-Feb. 4000 w.

*3943. The World's Principal War Fleets (A review of development of war vessels from earliest times to date, and of the present military marine of the entire world). Eng, Lond-Jan. 24. 5500 w.

*3950. Birmingham and Bristol Channel (Illustrated brief description). Eng, Lond-Jan. 24. 1000 w.

*3954. Water-Tube Boilers (An interesting continuation of the debate upon circulation in water-tube boilers, in which four correspondents take part). Engng-Jan. 24. 3800 w.

3987. Steam Plants of the St. Paul and St. Louis (Illustrated detailed description). Power-Feb. 2500 w.

4011. Care of the Modern Marine Boiler. T. W. Kincaidy (A practical paper). Am Mach-Feb. 6. 500 w.

4031. The Reorganization of the Engineer Corps of the Navy. Ira N. Hollis (A critical analysis and review of the bill for reorganizing the engineer corps of the United States Navy. The first part discusses the proposed increase in the number of commissioned engineers; duties of engineer on shore and at sea; the necessity for higher standards of skill to keep pace with advances in marine engineering; the lack of marine knowledge usual with secretaries of the navy; their liability to be deceived by men with more tongue than talent, and the consequent thwarting of the efforts of able engineers to improve the efficiency of the service, and other matters of present interest and importance). R R Gaz-Feb. 7. Serial. 1st part. 3500 w.

*4043. Shipping on the Great Lakes. Henry S. Pickands (Illustrated account of the industry and improvements in marine engineering, especially as manifested on the Great Lakes). Yale Sci M-Feb. 2800 w.

†4057. A Rubber Boat that Crossed the Sea. From *Harper's Weekly* (Description of a novel boat, the invention of E. L. Perry, which carried three men across the Atlantic nearly 29 yrs. ago). Ind Rub Wld-Feb. 10. 500 w.

†4066. The Relation of Naval Architecture to Proper Sanitation. J. R. Tyron (An important and able discussion of effective and defective sanitation of ships, reprinted from the annual report to the United States Navy. The question of naval construction as bearing upon sanitation, is exhaustively reviewed). San-Feb. 13000 w.

MECHANICAL ENGINEERING

Accuracy in Workmanship.

AN editorial in *The Engineer* (London, Jan. 24) begins with the following paragraph:

"Of the thousands of engineering firms all over the globe, the number which insist on a close approximation to accuracy of work might be expressed in two figures; yet the other firms, which are content with less perfect work, turn out machinery which performs its duties satisfactorily, and even in certain cases with great efficiency. It is not an uninteresting investigation, then, to look into the conditions which decide the particular degree of excellence which is most desirable in mechanical construction, and to attempt to arrive at a conclusion which may to some extent be capable of general application."

In this attempt the writer has undertaken a difficult task. The subject must be viewed from the standpoints of both the manufacturer and the purchaser; and that these are apt to differ very widely goes without saying. The purchaser, having agreed upon a certain price for a special construction, wants as good work as can be produced within the limits of the specifications upon which the contract is based. The manufacturer, while he generally desires the work to be creditable to his reputation, naturally objects to refinements which he thinks unnecessary to the proper working of the machine or appliance he has agreed to supply. He keeps at least one eye on his prospective profits, and, in our opinion, is justified in constantly regarding the profits, so long as he executes the letter and spirit of his agreement. He is not in business for his health any more than is the purchaser. The right of the purchaser to get as good work as he can for his money, and the right of the manufacturer to make as large a legitimate and honest profit on a job as he can, must both be conceded, but these rights, being forces operating in opposite directions, are liable to lead to disturbance, unless they are balanced with exactness by the terms of the agreement.

We reach a different phase of the subject in the case of the manufacturer who, having decided what price he can judiciously place on the machines or appliances he is placing on the general market, seeks to fix upon such a degree of finish and accurate workmanship as will insure successful operation and good sales, and at the same time leave a satisfactory margin of profit.

It is this phase with which the article quoted deals more particularly, and, as we think, not very satisfactorily; for, beyond the already well-recognized principle "that in the long run a high degree of accuracy pays well" in the manufacture of large quantities of any specialty, no conclusion which may to any extent "be capable of general application" appears to have been reached. At the same time, the difficulty, if not impossibility, of formulating any generalization for a matter that, in its very nature, depends upon individual judgment must be recognized.

Nevertheless, this article contains many valuable hints upon a subject of ever-present interest. The question, which is a simple one to the purchaser, is complex enough when viewed from the manufacturer's stand-point.

"Putting aside for the moment the moral effect of the standard of work on his men, he has to take into account (1) the number of similar articles required; (2) the probability of future orders; (3) the cost of the necessary tools, both in outlay and in wear-and-tear discount; (4) the increase or decrease of highly-skilled labor; (5) the time of manufacture; (6) the conditions affecting his particular case, as shop space, standard efficiency of staff, etc. We have put the number of similar articles required and the probability of future orders in the first place, because, provided these be sufficiently high, they overweigh all other considerations. We are well aware that there are still many manufacturers turning out large quantities of machinery identical in all parts, who do not insist on a high standard of excellence. There can be little question that this is false economy. The necessary outlay in tools may mean drawing a considerable sum from the capital, but it will be returned in the increased facility of manufacture. Let us explain this more fully; and, for the sake of example, we will take the case of a large number of small steam-engine cylinders, all made from the same drawings. The quantity actually on order at any time, it should be observed, does not affect the question, if the probability of future similar orders is considerable, or if the price for the first lot is sufficient to partly cover the expense of the tools. The maker who is not prepared to work accurately planes up one cylinder end, bolts the cylinder on to a face plate, and bores it out with a simple tool. His lathe probably is not in the best condition, or made by the best maker. Consequently, his cylinder is a little taper and considerably elliptical, perhaps to the amount of several hundredths of an inch. His cylinder covers have in the meantime been turned and the stuffing-box bored; he prefers probably to leave his piston until he can gage the cylinder with an indifferent pair of callipers and turn it to fit the smaller diameter. The holes for the cover studs have been marked off with compasses, or at best with a plate template, and drilled with a shaky drill through the cover. These holes are scribered through on to the cylinder ends, and the tapping holes drilled, as accurately as a man can judge by his eye, concentrically with the clearance holes scribered on. They are then tapped by hand, Again, he chips out his ports to scriber lines, and makes his valve in the same way. It is unnecessary to go further. What is the result of all this ramshackle work? The cylinder has to be scraped out true, and the covers adjusted to the position in which the rods work through them best. Some studs are not vertical, and have to be knocked straight; others fit too tight or too loose in their holes; others are not in the right position, and the cover holes have to be filed out to suit. Tedious complications occur with the valve, and so on and so on. How much simpler are the same operations as performed by the best maker? The cylinder is held steady and two cuts taken through with long cutting tools gaged to a thousandth of an inch over the edges, and the ends faced from the boring bar. The stud holes are drilled from cast-iron copies through holes bushed with hard steel, and are tapped and studded in a machine that insures fit and verticalness; the ports are milled out to a hard steel copy also. And so with the corresponding parts. What is the result? The engine can be put together, and work without hitch in one-fifth the time the other takes. Through all the remaining details the same class of work is carried out. Fitting is reduced to a minimum; it is merely the putting together of parts which are gage fits. But where fitting has to be done the same accuracy is observed; faces are scraped, not merely filed, and holes made gage-size and drilled through jigs, and all boring and turning done to fixed callipers or bar gages. It is evident, therefore, that the superior maker can reduce slightly his number of highly-skilled hands, though it must be borne in mind that a certain number taken from the fitting shop must be transferred to the tool shop and charged solely with the upkeep of all the accurate tools, templates, jigs, etc. On this point, then, he does not gain much, if at all, and on the original outlay on tools he is considerably the loser. For really accurate work no feature is of nearly so greet importance as the condition of the machine tools; and of all the tools the lathes and milling machines require the greatest perfection and the tenderest care. No one who has not had practical experience of tools of different qualities can fully appreciate the vast difference between even a good tool and a perfect one. The manufacturer's outlay on tools must be very high, for he must have the very best tools, keep them in the best condition, and employ good workmen on them. We fancy this one of the principal obstacles to great accuracy of work in already established firms. They are not prepared to go to the expense of large new plants, and they find they are totally unable to work to a fraction of a thousandth of an inch with their existing tools, so give up trying for a 'fit' at all."

Increasing the Heating Surfaces of Boilers.

A FALLACY that misleads many designers of boilers who are not fully versed in the principles that govern the transmission of heat is well dealt with by Mr. F F. Hemenway in *American Machinist* (Jan. 30). This fallacy is that a large heating surface necessarily and of itself is almost sufficient to make a good, economical boiler. Many even make the mistake of giving this feature of a boiler so paramount importance that they sacrifice other essential features to gain the large surface, and then are surprised to find that, after all, they have an inferior or worthless design. This mistake is not made by trained engineers familiar with the action of heat in generating vapors from liquids; but unfortunately, within the last few years, a host of designs—especially of boilers for heating buildings—have been made by men who knew little or nothing of the physics of steam production, and who have seized upon the one idea of large heating surface as the principal thing needful in boiler construction. In the advertisements of these makers the words "heating surface" and the figures representing it are printed in large type, and other things no less important are overshadowed.

Mr. Hemenway does a timely service to the public by his criticism of this fallacy. Unless heating surface be judiciously placed with reference to grate, and properly proportioned to the grate surface and the smoke-flue,—in short, if the dependence of each detail upon every other, and the law of this dependence, be not recognized,—nine out of ten such designs will fail of good results, and the few cases wherein some measure of success is reached will be purely accidental. Mr. Hemenway says:

"It is not always the added heating surface that is to be objected to, but the manner in which it is obtained. But the additional heating surface is not always desirable. I have reasons for remembering the test of a steam engine, three boilers being used for supplying steam. The first result of the test was not satisfactory, and on the second day one of the boilers was cut out, when what was desired was obtained, notwithstanding the reduction of heating surface.

"Some ten years or more ago it was essayed to put a wonderful 'economizer' on the market; big stock company, and all that. There was so much pipe about the arrangement that you had to trust to imagination as to the location and general shape of the boiler; and, by the way, there must be a good many pipes in order to materially increase the heating surface. I never heard of it after it had been applied to two boilers. I only knew that I incurred the lasting enmity of one of its promoters by venturing to say a word as to what I thought objectionable about it, particularly the vast array of pipe joints exposed to high temperature.

"If you have a boiler that permits the gases to escape at too high temperature, the remedy—and in the end it is likely to prove the cheapest remedy—is to buy a new one, bearing in mind that heat is necessary for producing chimney draft, as well as for imparting heat to water; and, in any event, no important change should be made in a boiler, except by advice of a competent engineer known to be reliable and disinterested."

The Design and Testing of Fans.

IN a paper by Messrs. H. Heenan and W. Gilbert, according to an abstract printed in *Machinery* (London, Jan. 15), experiments are described which were directed to the determination of the best form of fan-blade, and fan-case, and the most economical diameter and speed of fan, for moving any required volume of air at a given pressure. After reference to some of the practical difficulties involved, an outline is given of the manner in which the performance of a fan should be tested, a blast fan 28 in. in diameter being selected for illustration. A distinction is made between velocity and pressure gages for various deliveries, and the method of drawing the characteristic curve is explained. The effect of the variation in the shape of the blades is next studied, those chosen having tip angles of 35 deg., 60 deg., and 90 deg., respectively, the fan centre being 17 in. in diameter. It was shown that the radial blade gave the best result.

The experimental apparatus used for testing the smaller classes of fans is described. Each fan delivered air through a circular iron tube into a boiler flue 2 ft. 6 in., in diameter and 18 ft., long. Circular orifices of various sizes were fitted in the flue to form graduated resistances, and the air-velocity was estimated by an anemometer at the open end of the flue. A transmission dynamometer measured the power absorbed by the fan. It was remarked that considerable differences in the velocity of the air might exist at the same cross-section of the delivery-tube of the fan, in proof of which drawings were exhibited of the curves determined by experiment and of those obtained from some of the fans tested.

The Heenan mine-ventilating fan, tested at Parkend Collieries, had a fan-center of 7 ft. in diameter and 2 ft. in width. This fan was designed to pass 20,000 cu. ft. of air per minute at a water-gage of 3½ in., and the result was found to agree well with the rules developed by the authors. A variable resistance was provided by closing the mouth of the air-drift to a greater or less extent. The horse power given to the fan was obtained by indicating the engine. Characteristic curves for tip-speeds of 5,000 ft., 6,000 ft., 8,000 ft., and 9,000 ft. per minute were given. The maximum efficiency was 70.3 per cent.

The comparative output of fans of the same type, but differing in size, showed that, if they were run at the same tip speed, and at the same pressure shown by water-gage, the air-discharge would be proportional to the center section of the fan,—that is, to the diameter multiplied by the width. This being so, if the air discharged from any fan and the corresponding brake horse-power be divided by the area of the center section, the characteristic curves plotted from these data, with the observed water-gage, will be the same for all sizes of fans of the same type. It was shown that the dimensions of a fan could be determined from these curves, so that the most economical results may be obtained; and an apparatus was described by means of which the accuracy of the water-gage tips, used for the measurement of air pressure and velocity, was tested. To test the facing gages the following method was adopted. The tip was moved at a known velocity through air at rest, by causing it to describe a circle 20 ft. in circumference, and provision was made whereby a water gage recorded the air pressure set up. The pressure in feet of air due to velocity in feet per second was obtained by dividing the square of that velocity by 64.4; and it was found that a facing-tip, whether conical, parallel, or bell-mouthed, when used in connection with a water-gage, would record this amount correctly. Three side-tips, which had been used to determine the compression existing in a stream of air flowing through a pipe by placing them at right angles to the direction of the flow, were next tested.

The object was to determine how far these tips were affected by induction. Two of the tips consisted of pieces of pipe, ¼-in. bore, and having an external diameter of $\frac{5}{16}$ in. and ½ in. respectively. It was found that, owing to induction, the pressure recorded was less than the correct amount by a quantity equal to 45 per cent. of the gage-reading, which would represent the velocity of the air-stream in question. The third side-tip had a plate 2 in. in diameter screwed to the end of the pipe, the edge of the plate being bevelled. The readings of this gage were found to be correct, and it was used in all experiments recorded in the paper. The tip-speeds used varied between 60 ft. and 190 ft. per second. A series of tests made to determine the efficiency of an expending chimney were then recorded. Air was passed from a fan through a delivery-tube into an expanding chimney, the sides of which could be set at any desired angle to the center line of the tube. The efficiency for any angle was obtained by dividing the vacuum observed at the throat of the chimney by the calculated vacuum due to the reduction of velocity of the air as it passed from the inlet to the outlet of the chimney.

Electric Arc Welding.

AN interesting historical sketch of the rise and progress of the art of electric welding is presented by Mr. William Handy in *Electric Power* for January. Attention is given in this paper more particularly to electric arc welding. The Benardos system comes in for a large share of notice, and the description of examples of work done by this system are interesting. Mr. Handy says:

"A steel roll, in which the wobbler end has become so much worn that the coupling box turned round without driving it, was taken out, and the damaged corners built up, by the aid of the arc, to their original size, the whole job being completed within twenty-four hours. A similar difficulty occurred with a cast-steel helical wheel weighing over six tons, belonging to a reversing plate mill. The steel was too soft; so the wobbler ends were worn, while the teeth were still perfect. The spare wheel was put in place, and the ends of the shaft, which had been removed, were rapidly restored to their original size. In like manner, bearings that have been worn down a dangerous amount can be built up and re-turned, restoring the shaft not only to its original form, but also to its former strength. In one instance some shafts for driving live rollers were made two and one-half inches too short, and the extra length of shaft was electrically welded on by building up. As an example of a larger job, cast-iron cogging mill live rollers, which broke at a point where they were 10⅝ in. diameter, were electrically welded satisfactorily. The teeth of cast-steel wheels which have been broken while working have also been repaired without removing the wheels from their shafts.

"For rapid boiler repairs, the work is most efficient. It enables a patch to be applied in difficult places, where riveting would be impossible without partly taking the boiler to pieces. For instance, in a boiler wasted by corrosion at a point on the outer shell, when the defect was cut away, there was a hole 5½." A piece of mild steel plate was fitted over the hole so as to lap 1½" all around. It was satisfactorily welded on by applying the electric arc to the junction of the plate and shell. The whole job, including testing by hydraulic pressure, was completed in ten hours. To have at hand a means of mending broken parts without removing them from their places must be of great advantage, especially in a rolling mill where breakdowns are frequent and costly.

"The minimum requirements for the kind of electric welding in use at Spencer & Co.'s are three hundred amperes at a pressure of eighty volts, while five hundred amperes are preferable. This means fifty-four electrical, or seventy indicated h. p. This may be obtained from an engine and dynamo of that size, or from a plant half the size, aided by a battery of accumulators. Thirty to thirty-five per cent. of the energy needs to be wasted in resistance, in order that the total resistance in the circuit may not be greatly varied, as the workmen shorten or lengthen the arc in the manipulation of the job.

"When there is no electrical apparatus on the premises, it becomes a very serious matter to fit up a plant for a few jobs, but when there is apparatus and work to be done of the above class, it will be a great saving.

"The precautions to be observed are not many. The metal to be welded, if iron or steel, should be the positive pole, but, if of other metal, such as lead, it should be the negative pole. The volts should be sixty-five and ninety-five at the machine, and should be reduced thirty to thirty-five per cent. in the passage of the current to the weld. In 'building up,' the metal introduced into the weld should be as nearly as possible of the same composition as the article to which it is welded, and the workman should remove the slag formed on the surface of each layer added, before commencing to add another. In cases where the part to be 'built up' projects above the surrounding surface,—for instance, a tooth,—each layer of material added should be retained in position, and prevented from flowing away by forming a ridge of finely-ground ganister clay around the circumference of the layer to be added. Many firms have tried this process, but it has found its best outlet for mending castings and for doing repair work of the sort above mentioned."

The methods of Coffin (American) and Hoho and Legrange (Belgian), and the Zerener method recently reviewed in this department, are also discussed. Not much is added to previous knowledge, but the subject is presented in a popular and agreeable style.

The Willans Engine.

PROFESSOR JOHN E. SWEET, writing in *Machinery* for February of special features seen by him in British work-shops, closes a very interesting contribution with the following description. "At the engine-works of Willans & Robinson, Thames Ditton, two wonders await every American, except those who will not admit that anything can be done except what we do. There are a number of features about the engine that students in engineering have been taught to believe are contrary to the best practice, but experience shows that they produce the results, and the style of the engine renders good work necessary, and the good work produces the results where it would be wasted on other designs.

"The cylinders and steam chests are piled up one above another, and it is important that they be true and in line. These cylinders are bored, reamed, and faced on an ordinary lathe, a regular English lathe, with no features except a holder attached to the slide rest to carry the reamer,—that is, the reamer is held and driven through the work by the slide rest, and not by the tail stock. Mr. Eaton Shore (the works manager, who, as well as every one connected with the company, gave me every attention, all information, and every opportunity possible to see and learn) is firmly of the opinion, as I am now convinced, that the results obtained could not be continuously produced by the tail stock feed. As an example, a half-dozen cylinders some 14 in. diameter and a foot or so deep, with a flange outside at one end and inside at the other, were by the lathe, just finished. One taken at random was sent to the testing floor and placed on an oiled surface plate. The testing plug, made like a web pulley with about 2½ inches face, was started in the cylinder and crowded down until about even at the top, when, with a finger on the top at one side, the plug was shown to be so free from contact with the sides of the cylinder as to spin around like a top. The man then stood upon the plug, and it carried his weight on the air. This job probably could be done in any good shop, if one went at it the right way, but for one thing; the castings are made of re-cast pigs, re-cast after the mixtures are made. This makes a uniform iron, which is more likely to keep its shape, but it is very hard, and that makes the work difficult. Such hard cylinders and the accuracy contributes to the success of the engine, but such accuracy would be of no particular advantage in an ordinary engine, when the cylinders are distorted by steam in one place or on one side and exhaust in another.

"The Willans is, in its design, workmanship, and method of construction, so dependent one upon the other that it is not easy to describe how things are done, and give them their due force, without describing the engine itself; and the whole would be more than a single article would cover. . . . They have in use what I understand is a common thing,—a flexible copper steam pipe, capable of resisting any required pressure, that bends around like a rubber hose. Not a double wire arrangement like Almond's, depending on mechanical fits, but an absolutely tight copper-pipe, constructed in such shape as to be easily bent around; an ideal device for an erecting floor.

"It is useless to attempt a description of the interesting and wonderful things to be seen at the works of the Willans & Robinson Co., and to one who appreciates wonders some such thought as this must come to him,—the death of a great engineer is a loss to the world. When Peter William Willans died, the world lost a genius."

Professor Sweet always writes interestingly, and is altogether one of the most keen-eyed observers of mechanical progress this country possesses. It is to be regretted that his contributions to mechanical literature are not more frequent.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

3813. On Wastes and Shop Handling. John Richards (Extracts from recent lectures before the students of Leland Stanford Junior University, Palo Alto, Cal. Percentage that should be added for waste, in estimating cost of machinery, methods of arriving at weights, through dimensional data, and suggestions to designers directed to avoidance of excessive waste of material in construction). Ir Tr Rev-Jan. 23. 1600 w.

3870. The Forge Shop at the University of Nebraska. C. R. Richards (Illustrated detailed description). Am. Mach-Jan. 30. 600 w.

3873. The Comparative Efficiency of Belts and Ropes. M. E. (A critical review of the experiments carried out by the Société Industrielle du Nord de la France, at Lille). Am Mach-Jan. 30. 1400 w.

3875. Some Special Features Seen in British Work Shops. John E. Sweet (A very interesting account given by a keen observer and closing with a warm tribute to the genius of Peter William Willans, whose death was a loss to the entire world). Mach-Feb. 2500 w.

3876. Pattern Shop Supplies. John M. Richardson (Judging from the first part, this is to be a series of practical hints and suggestions, relating to supplies and appliances for pattern shop use with information gained from experience as well as from other sources). Mach-Feb. Serial. 1st part. 1600 w.

3877. Observations in an Old Shop. Ill. (Shop of the Silver and Gay Co., North Chelmsford, Mass. One of the pioneer shops of this country, established in 1832. Differences between tools of sixty years ago and those of present date are noted). Mach-Feb. 1100 w.

3878. Practical Notes on Steel. (S. W. Goodyear (The position is taken that, in general, steel will behave well if applied to the purposes for which it is best adapted, and that, therefore, it does not deserve the reputation of being refractory and unmanageable, in which it is held by mechanics. The article is directed to the guidance of mechanics in the selection of steel adapted to special purposes, and the judicious selection of adaptations for special qualities of steel). Mach-Feb. 2300 w.

3879. Aluminum Alloy to Replace Brass (An alloy which if it proves to possess the qualities claimed must prove of value in machine construction). Mach-Feb. 600 w.

3880. Blow-Out Pipes on Boilers. W. A. Carlile (Practical treatment of the subject). Mach-Feb. 1300 w.

*3896. The Helve Hammer in a Railroad Shop. O. H. R. (An excellent practical article in which the dies for a great variety of work done with this class of hammers are described and illustrated. This article will lead to a higher impression of the value of one of the oldest types of machine hammers which still retains a field of usefulness notwithstanding it has been thrown into the back ground by modern improvements). Loc Engng-Feb. 1300 w.

*3899. Sketching. O. H. R. (A first class practical paper full of useful hints and presented in concise and clear style. The usefulness of the accomplishment of being able to make readily a good free hand sketch is exemplified, and by following the directions given, there are few who could not acquire it). Loc Engng-Feb. 2400 w.

*3944. Casting Pump Pipes. Ill. (Describes Scotch practice which differs in some respects from English practice). Eng, Lond-Jan. 24. 1600 w.

*3948. Accuracy (Editorial dealing with the degree of accuracy most desirable in mechanical construction, viewed both from the standpoint of the purchaser and the manufacturer). Eng, Lond-Jan. 24. 2200 w.

4062. Belt Experiments (A general review of results obtained by various experimenters, including experiments of Morin, Briggs and Towne, Leloutre, Lewis, Lanza, Fauquier, and the recent experiments at Lille). Bos Jour of Com-Feb. 8. 2000 w.

Steam Engineering.

3569. Steam Consumption of an Engine.—How It May Be Measured. Thomas Hawley (Extract of lecture delivered in Lowell Free Course, at Wells Memorial Institute, Boston. Discusses methods of interpreting indicator cards, and the use of data so obtained in computation). Bos Jour of Com-Jan. 11. 2000 w.

3574. Some Things Engineers Should Know (A series of questions and answers relating to practical management of engines and boilers). Lord's Mag-Jan. Serial. 1st part. 4000 w.

*3590. On Entropy and Entropy Diagrams. Prof. Boulvin (The graphic method in the study of thermodynamics is shown in this paper to be of the highest value. An experimental application of the entropy method to a compound condensing engine is described, with results and conclusions). Engng-Jan. 3. 5000 w.

3700. Heating from Intermediate Receivers (An attempt to show wherein heating by this method results in gain, and to determine the gain quantitatively). Eng Rec-Jan. 18. 900 w.

*3709. Circulation in Water-Tube Boilers (Illustrated detailed description of a remarkable series of experiments carried out at Messrs. Yarrow and Co.'s Works (England), with editorial introductory remarks. The apparatus used and illustrated is elaborate and costly, and the experiments throw much light upon this much debated question). Eng, Lond–Jan 10. 4800 w.

*3710. Megass and Refuse Furnaces. William Price Abell (Illustrated detailed description of furnace for utilizing refuse as fuel, and a general and practical discussion of the subject). Eng, Lond–Jan. 10. 2200 w.

*3717. The Wheels and Why They Burst. Charles Henry Benjamin (Read before the Elec. Club of Cleveland. Includes also a description of a steel built up fly-wheel). St Ry Rev–Jan. 15. 2800 w.

†3804. Measurement of Temperatures of Steam. D. S. Jacobus (This paper presents experiments made to determine how nearly thermometers, placed in mercury or oil wells inserted in pipes, register the temperature of steam passing through the pipes. Apparatus illustrated and method explained with some of the conclusions derived). Stevens In–Jan. 6500 w.

*3818. The Combustion of Powdered Coal (Illustrated description of the Wagener apparatus, with table of data of an experimental trial, conducted by Mr. Bryan Donkin and Prof. Kennedy of a Cornish boiler, fired according to this system. No fan is required for the operation. The fuel is fed to the furnace by a sieve and an ordinary chimney supplies the necessary draft). Engng–Jan. 17. 700 w.

*3821. Water-Tube Boilers (Correspondence—Critical discussion of recent experiments, by engineer G. Gretchin, of the Russian Volunteer Fleet, Charles Bellens, of Paris, F. Strickland, and John Thorn, M. I. N. A. Interesting points are brought out in this running debate). Engng–Jan. 17. 2200 w.

*3823. Receiver and Condenser Drop. A. C. Elliott (The belief that "drop" dries steam is declared to be an ancient superstition. Deals with the subject mathematically and thermodynamically). Engng–Jan. 17. 1600 w.

*3833. The Efficiency of Motors (Editorial review of the technical meaning attached to the word "efficiency" as now applied in records of steam engine trials). Prac Eng–Jan. 17. 700 w.

3871. The Value of the Steam Jacket. Charles T. Porter (Heat does the work. The elastic steam is only a medium. The thermal changes and exchanges in steam cylinders are traced, and it is shown that the jacket is an economical appliance). Am Mach–Jan. 30. 1500 w.

3872. Increasing the Heating Surface of Boilers. F. F. Hemenway (A criticism of a tendency, which is chiefly manifested by those who assume to design boilers, with insufficient knowledge of principles. It does not follow that the larger heating surface belongs to the most efficient boiler). Am Mach–Jan. 30. 1100 w.

*3897. New York, Ontario & Western Passenger Locomotive (Illustrated brief description with table of dimensions). Loc Engng–Feb. 800 w.

*3898. Ten-Wheel Pittsburgh Compound for the Vandalia (Illustrated brief description). Loc Engng–Feb. 400 w.

*3939. The Solignac Mixed Boiler (Interesting illustrated detailed description). Am Eng & R R Jour–Feb. 2400 w.

*3955. Trial of Compound Engines. Michael Longridge (Trial of a pair of beam engines with steam-jacketed cylinders working compound. Extensive list of data obtained, followed by comments upon indicator diagrams and conclusions). Engng–Jan. 24. 3500 w.

*3956. On the Surface Condensing Plant at the Newcastle and District Company's Electric Lights Works, Forth Banks, Newcastle, on the Tyne. William Cross (Paper read before the North-East Coast Inst. of Engs. and Shipbuilders. Illustrated detailed description). Ind & Ir–Jan. 24. 2000 w.

3976. On the Support of Long Cylindrical Boilers (Practical treatment of proper and improper methods with diagrams). Age of St–Feb. 1. 1000 w.

3977. Sectional Water Tube vs. Shell Boilers. L. G. Read (The pros and cons of this subject are summed up in this paper). Age of St. Feb. 1. 2400 w.

3988. Water Gauge Glass Failures. P. M. E. (Causes of breakage, and their relation to the higher pressures now carried, with practical hints). Power–Feb. 1600 w.

3990. Experimental Determination of the Efficiency of Steam Boilers with Varying Rates of Fuel Combustion. F. G. Gasche (Methods whereby the subject of boiler efficiency can be satisfactorily studied. Formulæ constituting a rational basis for such study). Power–Feb. 1800 w.

3991. Cause of Fly-Wheels Bursting. W. K. Austin (Lessons from experience and observation. Jarring is considered a potent factor in the destruction of fly-wheels). Power–Feb. 900 w.

4013. Spray Nozzles for Cooling Water of Condensation. Ill. (Method of using water for condensing steam over and over again in places where water supply is limited). Am Mach–Feb. 6. 200 w.

*4079. Can the Cost of Power be Reduced? F. Riddell (The answer to the question is affirmative for many mills now operating, and hints at methods for stopping small leaks are given). Am Miller–Feb. 1700 w.

Miscellany.

*3585. Factories and Workshops). A bill that came into operation in England, on Jan. 1, 1896, is somewhat criticised and its benefits noted). Arch, Lond–Jan. 3. 2000 w.

*3592. The Le Blaut Steam Road Carriage (Illustrated detailed description). Engng–Jan. 3. 4400 w.

*3624. American Self-Propelled Carriages (A very thorough review of the state of the art in America, with illustrations and general description of the principal carriages of this class that have been brought out in the United States). Eng, Lond–Jan. 3. 4400 w.

3630. Compressed Air Mechanisms. Charles Henry-Cochrane in "The Wonders of Modern Mechanism" (A review of the use of compressed air as a motive power and for various mechanical purposes). Progress of the World–Jan. 1000 w.

3643. The Vicissitudes of a New Industry (A most instructive article given in the form of a letter from a friend solicited by an inventor to take stock in a company formed to manufacture a new and valuable patented improvement. It might profitably be read by many now contemplating the best way to commercially exploit new improvements). Ir Age–Jan. 16. 3000 w.

3660. The Gates Iron Works Drawing Room. John Randol (Illustrated detailed description, with plan of room, etc). Am Mach–Jan. 16. 2200 w.

3671. The Water of the Drainage and Ship Canal, and Its Transmission to Chicago. H. S. Putnam (A paper read at a meeting of the Illinois Chapter of the American Institute of Architects, claiming that both from an engineering standpoint and financially one can scarcely overestimate the importance of this canal as a source of power for the city of Chicago). Elec Eng–Jan. 15. 2200 w.

*3707. The Jenny Lind (History of a locomotive of great interest as being in a large measure the forerunner of the standard type of English locomotives. The first part describes the incidents connected with its building and competitive trial, and promises illustrations of details in a future number). Eng, Lond–Jan. 10. Serial. 1st part. 1200 w.

*3708. The Theory of the Lubrication of Plain Parallel Surfaces. R. M. Deeley and C. E. Wolff (An important paper reprinted from the Transactions of the Royal Society, with nine tables of constants). Eng, Lond–Jan. 10. 3000 w.

*3749. An Autographic Testing-Machine Attachment. Thomas Gray (Description of a device whereby automatic and autographic records of the relation between the force applied and change of dimensions are obtained). Digest of Phys Tests–Jan. 2700 w.

3796. Notes on the Invention and Development of the Slide Rest. W. F. Durfee (Historical in character and of much interest). Am Mach–Jan. 23. 2800 w.

3797. A Turbine of the Niagara Power Co. Ill. De Volsen Wood (Results of calculations of the performance of a large turbine of the Fourneyron type, based upon data supplied by Prof. Coleman Sellers). Am Mach–Jan. 23. 1500 w.

†3801. A Curious Mechanical Movement. C. W. Mac Cord (Describes and illustrates an ingenious piece of mechanism for turning on and shutting off gas at a distance and which is possibly applicable to other purposes). Stevens In–Jan. 1400 w.

*3814. The Design and Testing of Centrifugal Fans (Abstract of a paper read by Messrs. H. Heenan and W. Gilbert, disciples of a method and apparatus for determining best form of fan blade and fan case, and most economical speed and diameter of fan to move any desired volume of air under any given pressure). Mach, Lond–Jan. 15. 900 w.

*3822. Experiments on Wind Pressure. H. C. Vogt (General discussion stating the writers' relation to the experimental researches of Prof. Irminger, and giving a formula for computing efficiency of wind propellers). Engng–Jan. 17. 2400 w.

*3824. The Strength of Cylindrical Shells. F. Keelhoff (Very abstruse mathematical discussion. The conclusion is reached that it is useless to take any account of the action of the ends in modifying the stresses in the shell of an ordinary boiler, and that the effect of the ends is as likely to increase as to diminish these stresses). Engng-Jan. 17. 1800 w.

†3842. A Coming Revolution in Power. F. Jarvis Patten (The writer looks for a "gas age" and prophesies a wonderful revolution due largely to the perfection of the gas engine). New Sci Rev– Jan. 2000 w.

3852. The New York Trade Schools. Ill. Owen B. Maginnis (An article in praise of these schools, and an account of a recent visit to them). Arch & Build–Jan. 25. 1300 w.

3912. Progress Toward the Age of the Horseless Carriage. T. A. De Weese (Illustrated historical sketch of progress in this field). Cos–Feb. 3400 w.

*3949. On Measurements of Small Strains in the Testing of Materials and Structures. J. A. Ewing (An important and exhaustive illustrated paper, with description of numerous experiments, and tabulated results. The experiments were made with a new kind of extensometer, which is described in detail). Eng, Lond–Jan. 24. 3500 w.

*3963. The Berrenberg Mechanical Pump (An illustrated description of a pump for the exhaustion of an electric incandescent lamp). Elec Rev, Lond–Jan. 24. 1600 w.

3989. Friction of Bearings. J. H. Holmes (A learned discussion of the friction of bearings other than plain, parallel, sliding contact bearings. The subject is ably treated). Power–Feb. 1800 w.

4010. Water Motors and Their Power. G. D. Hiscox (Deals with the class of motors now upon the market for supplying small power. Details of their construction are illustrated). Sci Am Sup–Feb. 8. 1800 w.

4012. The Measure of the Instantaneous.—The Time Occupied in Oil Engine Explosions. Tecumseh Swift (An important question ably discussed). Am Mach–Feb. 6. 700 w.

†4058. Are Patents Worth Anything? C. D. Frost (A reply in part to an article in *Electrical Engineering* (Chicago) and giving the writer's views on the valuelessness of letters patent). Ind Rub Wld–Feb. 10. 1400 w.

*4077. The English Steam Whizzer (Illustrated description of a new device for washing wheat previous to grinding it. The process is so rapid and thorough that in passing through the whizzer, while the wheat is nicely cleaned, the grains do not absorb moisture enough to interfere with grinding, and moisture adhering to the surface is separated and thrown out by centrifugal force). Am Miller–Feb. 500 w.

MINING & METALLURGY

Treatment of Low-Grade Ore.

Gold and silver mining is one of the most profitable of undertakings when carried on in a business-like way. Most of the failures are due to ill considered action by the promoters in organizing the company, or the directors in its management; and the most serious blunder made by the latter is the adoption of a process for treating the ore which has not been sufficiently tested before installing the plant. An experienced engineer's judgment will go far in selecting the best method of extraction, but this method should be subjected to preliminary tests before the plant is bought. Mr. Edmund B. Kirby treats of this subject in a valuable article in *The Mining and Scientific Press* (Jan. 18) as follows:

"It is well understood that of the two general divisions, 'sulphid' and 'oxidized ores,' the former includes all those forms in which gold was originally deposited in veins. Within reach of the aerated surface waters the sulphid minerals are found more or less decomposed, with their gold contents set free. Nature has here done slowly the very work which would otherwise have to be performed in roasting furnaces."

With completely oxidized ores a high-speed California stamp mill should be used, which will treat ore from 35 cents to $1.00 per ton. Where the gold is free, but very finely divided, amalgamation must follow stamping. The Gilpin county (Col.) type stamp mill is of slow speed and designed for ores little or not at all oxidized. It will save sixty to seventy per cent. of the gold in the battery and on the plates. Telluride minerals will not yield to amalgamation or concentration, and must be treated by the chlorination or cyanid process. Combination milling means amalgamation followed by concentration.

"Two general types of combination plants are in use. In one the ore is crushed by stamps to the usual sand size, and then treated on vanners or other simple concentrating machines. The sands, now free from sulphids, are then ground fine and amalgamated in pans.

"In the second type the ore is crushed by rolls to about bean size. It is then treated in a complete concentrating plant of screens, jigs, hydraulic sizers, buddles, vanners, etc., more or less elaborate, according to the requirements of the case. The tailings from the concentrating department are then recrushed to sand size and amalgamated on plates or in pans. Combination plants of fifty tons' daily capacity cost from $30,000 to $60,000, and the expense per ton is also greater; but a much larger extraction is secured.

"When the problem cannot be solved by any of the above methods, it is necessary to resort to barrel chlorination or the cyanid process. In barrel chlorination all the sulphids must first be removed by roasting, before chlorine can act effectively upon the ore. This is more difficult and expensive than ordinary roasting, where a complete removal is not necessary. Another objection to the chlorination is that no silver is saved, and, since most gold ores also contain silver, the loss from this cause may be serious,

"The cyanid process requires no roasting, since the solutions penetrate the cleavage planes of the sulphid crystals and dissolve a large percentage of both gold and silver. Neither process will recover the gold present in coarse flakes and grains. Both require very expensive and carefully designed plants, which may cost $50 000 to $75,000 for fifty tons' daily capacity. Chlorination extracts ninety to ninety-four per cent. of the gold only, while the cyanid process recovers seventy-five to eighty per cent. of both gold and silver. The latter is, therefore, specially adapted to the lower grades of ores, and its expense is about two-thirds that of chlorination. Each process has its own field of application, and the question as to which is best for a given case is not easy to decide. At present the cyanid process is being applied to ores in three different ways:

"First—As an adjunct to the process of ordinary wet stamp milling. The tailings from the stamp mill are further treated in a cyanid department. This is the method in universal use throughout the South African fields. At first the old dumps of accumulated tailings were worked up, and then the cyanid plants were modified to take fresh tailings continuously from the stamp mills. The system has the following advantages: It is the cheapest of the three in cost of plant and expense per ton. All large grains of gold which would escape from cyanid solutions are saved by the amalgamation. Moreover, since many of the mills use concentrating machines, the sulphids are separated in a small bulk, and this is treated with more care and expense than would be profitable upon the ore itself. The disadvantage of the system is that the crushed material flowing as tailings from a wet stamp mill contains such a large proportion of flour-size particles or slimes that the cyanid solutions will not percolate through it. It is, therefore, necessary to separate the sands from the slimes, and treat only the former. The slimes, amounting to thirty per cent. of the total weight, have to be thrown away. The Johannesburg ores average $12 in gold, and the stamp mill amalgamation takes out about sixty per cent. of this, or $7, leaving $5 per ton in the tailings. Thirty per cent. of these tailings are thrown away as slimes, and the remaining sands are subject to cyanid treatment. This extracts seventy per cent. of the gold in the sands, making the total recovery $9.50, or about eighty per cent. of the gold originally present in the ore. The remaining $2.50 is lost. If it were only possible to treat these slimes effectively by cyanid, this system would be the one best suited to most mines in the United States. A cyanid plant could then be attached with ease to any western stamp mill, and the saving greatly improved. Up to the present such attempts in this country have been failures. Various plans have been proposed to overcome the difficulty, and it is probable that a working plant could now be built to treat slimes.

"Second—The ore is crushed in an ordinary dry crushing stamp mill. It is placed dry in vats, and the cyanid solutions allowed to percolate through the mass. This system has been tried in New Zealand, Australia, and various parts of this country. Its results have, on the whole, been rather unsatisfactory. The trouble is that dry stamp crushing produces so much fine powder that percolation is very difficult and slow.

"Third—The ore is crushed dry in a more complicated and expensive plant of rolls and screens. The object of this is to avoid the production of slimes, and thus to do away with all the difficulties of percolation. It is a very delicate undertaking to accomplish this without at the same time having the grains of ore so coarse that the solutions cannot reach their gold contents. The large number of failures which have occurred in the attempts to apply cyanid by this system have made it clear that, in order to ensure success, it is necessary to have a very expensive plant, designed by the best metallurgical skill."

Feeder for Powdered Fuel.

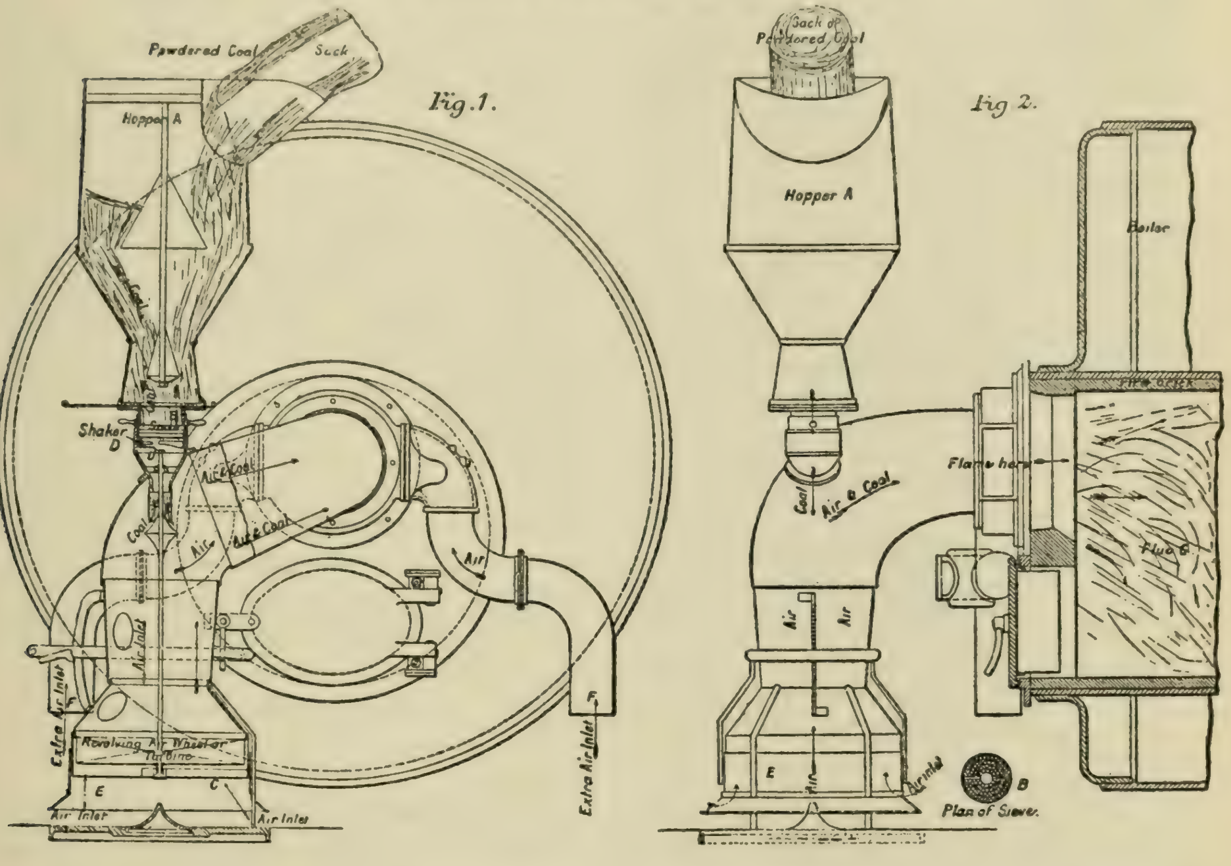
THE Wegener automatic system of burning powdered coal was devised in 1892. It was closely followed by the Friedeburg and Schwartzkopf systems, and has been in use at the Bermondsey works, England, for some time, where it gave an economy of as high as twenty per cent. over hand-stoking. The automatic stoker used in the Wegener system is thus described in *The Colliery Guardian* (Jan. 24):

"The Wegener apparatus has been much simplified, and now it would seem difficult to find a more elementary and yet efficient construction. The coal-dust is contained in an overhead conical hopper, at the bottom of which is a sieve, about 5½ in. in diameter. This sieve is tapped automatically so as to cause the coal to fall through into a vertical pipe, where it meets an upward current of air produced by the chimney draught. The mixed air and dust then pass directly into the boiler furnace by means of a quarter-circle bend on the vertical pipe. In order to shake the sieve, a fan in the air-pipe is driven by the natural draught, just like an old-fashioned smoke-jack, and, in turn, drives a small hammer, which taps the sieve about 150 to 250 times a minute. The strength of the blow is controlled by a spring and stops, both of which are adjusted by small hand-screws, so as to regulate the amount of coal used. The air supply is regulated by raising or lowering the lower end of the vertical pipe, which nearly reaches the floor. As the fan is placed nearly at the bottom of this pipe, some five feet below the sieve in the hopper, the falling dust does not reach it, and the moving parts generally are of very light and simple construction, so that the cost of repairs necessary will be light. In fact, an ordinary tinsmith could construct nearly the whole of the apparatus. The main air-supply pipe is some twelve or more inches in diameter, but additional air can be supplied by extra pipes closed by dampers. These are only used with very bituminous coal.

"The cost of pulverizing to pass through a 60-mesh screen, starting with slack coal, is given at about ten per cent., or not more than one shilling a ton. Any disintegrator, or other type of machine suitable for the purpose, is used. This item of cost has to be set off against the saving of labor in stoking and the cheapness of the fuel that can be used."

Though this apparatus is so highly spoken of, there are several points in construction which will strike an engineer at once as being inefficient.

THE WEGENER POWDERED FUEL FURNACE.



The Russell Process.

THIS method of silver extraction, having passed through the usual experimental stages, has reached a point in economical working where it attracts the attention of mill-owners generally. Tailings which would otherwise be thrown away are treated efficiently by these hyposulphite solutions, the silver recovered being an important item contributing toward a company's dividends. Mr. Carl A. Stetefeldt briefly describes the process* invented by Mr. E. H. Russell as follows:

"Russell discovered that a solution of a double salt of sodium and cuprous hyposulphite, formed by mixing sodium hyposulphite with copper sulphate, exerts a most energetic dissolving and decomposing action upon metallic silver, silver sulphid, silver minerals belonging to the group of antimonial and arsenical sulphids, and other silver-combinations. Hence, if a charge of ore is first lixiviated with ordinary sodium hyposulphite solution, and, subsequently, with a solution containing a double salt of sodium and cuprous hyposulphite,—this solvent is called the extra-solution,—an additional amount of silver is extracted, which would have been lost in the tailings by working according to the old method alone."

Results obtained on thirty thousand tons of tailings, treated by this process at the Yedras Mill, Sinaloa, Mexico, show a product averaging seven thousand ounces of silver per ton and the following extraction:

Year.	Value of Ore. Ounces per ton.	Per cent. Extraction in Assay Office. Russell Process.	Per cent. Apparent Extraction in Mill. Russell Process.	Per cent. Actual Extraction in Mill. Russell Process.
1888	19.49	62.70	60.14	62.74
1889	17.23	57.20	55.95	60.14
1890	13.46	49.26	48.37	46.84
Av'g's.	16.73	56.39	54.82	56.57

"Russell also discovered that lead can be completely separated from a sodium hyposulphite solution, as lead carbonate, by sodium carbonate. After decanting the solution from the lead carbonate, silver and copper are precipitated from it in the usual way. This method of separating lead prohibits the use of calcium polysulphid as a precipitant for silver, because calcium entering the regenerated lixiviation-solution would also be precipitated as a carbonate with the lead by sodium carbonate. Hence, sodium sulphid must be employed. A full investigation has demonstrated that this is by no means detrimental. Sodium sulphid and hyposulphite are more advantageously used in the lixiviation-process than the corresponding calcium-salts."

Fusibility of Sand for Furnace Bottoms.

THE qualities which go to make a firm refractory floor or bottom for furnaces used in heating steeel ingots or blooms previous to passing them through the rolls are well enumerated by Mr. Charles Ferry in *The Iron Age* (Dec. 19). He says:

"The grades of sand to which I have particular reference are those used for making bottoms of reheating furnaces in rolling mills. The characteristic feature of a good bottom sand is its ability to 'set,' forming a hard, durable furnace bottom. But sands which contain clay or are of a 'loamy' nature cannot be used with any degree of safety. The tendency of such sand is to stick to the hot iron; then, when a bar is rolled, a lump of the bottom sand is liable to be found imbedded in the finished product. While it is essential that bottom sand should set quickly after having been thrown into the furnace, it must not be of such a fusible nature as to become seriously affected by the heat of the furnace. If siliceous material, like sand, is partially fused, or even approaches that state, it assumes the same sticky property which clay gives it, and that causes trouble."

It was supposed by some that the percentage contents of silica determined the refractory nature of a clay. "This view is not supported by experiments, as is shown by the following analysis. Permit me to tabulate the analyses of two specimens of bottom sand.

	A, good Per cent.	B, poor (fire sand) Per cent.
Silica, total, SiO_2	91.55	91.47
Alumina, Al_2O_3 Ferric oxid, Fe_2O_3	7.40	4.88
Lime, CaO	0.51	0.21
Magnesia, MgO	0.11	none
Water of combination	0.61	3.61
Totals	100.18	100.17

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*"The Lixiviation of Silver Ores with Hyposulphite Solutions." Carl A. Stetefeldt, author and publisher, 967 Alice St., Oakland, California. Second edition, 204 pp. Cl. Price $5.00.

Coarser-grained sands require a higher temperature to make them "set," though the chemical composition may be identical.

"For the furnace in which several practical tests were made the sample A seemed to give excellent results, while sample B, which carried about the same quantity of (total) silica, did not 'set' hard. A bottom was made in the reheating furnace with sand B, but, even after waiting fifteen to twenty minutes, the sand would show no tendency to bind together.

"After such widely different results were obtained from two samples of bottom sand which apparently contained about the same percentage of silica, I came to the conclusion that the quantity of silica present was not the only characteristic of sand to be considered in determining a specimen suitable for this work.

"If chemical analysis is to be the only guide to choosing bottom sand, I think the results should be interpreted in a similar manner to that of fire clay. Before passing judgment upon a specimen of 'refractory clay' from its chemical composition, it is necessary to arrange the results obtained from analytical work in the following manner:

Silica (combined), Alumina, Quartz, } Refractory constituents.
Water (combined), Plastic properties.
Lime, Magnesia, Ferric Oxid, Fixed Alkalies, } Fluxes.

"Besides these chemical features of a bottom sand, there is an important physical condition which must not be forgotten,—*viz.*, the size of grain or degree of coarsenesss.

"As the more plastic clays—*i.e.*, those containing the larger percentage of kaolin or hydrated silicate of alumina—render the silica sands less refractory, it follows that, the more water the kaolin contains, the more fine-grained and plastic it will be, and the more it will impair the refractory nature of the sand. A clean sharp sand without water would also be without clay.

"The fluxes—lime, magnesia, iron, and the fixed alkalies—are the substances which play the most important part in the 'setting' of bottom sand. In the aggregate these constituents probably amount to four or five per cent. in many samples of bottom sand. The fluxing powers of these substances with silica are nearly all different; therefore, to bring about the same results the sand would require the presence of possibly twice as much of one as another. In other words, if the fixed alkalies were the fluxing base in one case and ferric oxid in another, of two samples of bottom sand which work practically alike, we would find the percentage of the latter would far exceed that of the former. It is possible that alumina assists the fluxes in the work of 'setting' bottom sand, but not enough to warrant our giving it credit for a decided basic nature. Then, too, we find it refractory and slow to combine with the fluxing impurities of the bottom sand. For this reason it is reasonable to believe that the effect of alumina in bottom sands is the same as in fire clay, for, when either is subjected to high degrees of heat, this constituent does not act like a base, combining with the silica to form fusible compounds."

The author thinks that it is better to develop an accurate system of chemical tests than to risk losses of steel or bottoms by practical tests with new sands.

The Coolgardie Gold Fields.

A CORRESPONDENT of *Indian Engineering* (Dec. 21) writes from Coolgardie as follows: "Coolgardie is a rudimentary mining town of shanties mostly, at the extreme southwest corner of a vast strip of auriferous territory—roughly, two hundred miles wide—which stretches obliquely across Western Australia into the utmost north of the territory known on the maps as the Kimberly district. The town of Coolgardie lies about four hundred miles due east of the port of Fremantle, which is close to Perth." A railroad establishes communication to Southern Cross, two hundred and forty-eight miles inland. the remaining distance being still in the hands of the contractor. The country is a dry sandy waste, "covered with a species of eucalyptus, the foliage of which spreads out at the top into a graceful fan that becomes very monotonous, while the absence of landmarks renders the traveler very liable to lose himself and die from thirst. Water is secured by cement-lined channels leading to catch basins, which are made rectangular in section in order to minimize evaporation, and are locally known as "Sooks." A temperature of 110 deg. is common, and the white laborers work through the eight hours in the usual way, taking no advantage of cool mornings.

The latest water-supply scheme proposed is to distil the water obtained from wells in dried-up lake bottoms. This water is salty, and it will cost £75 per week to distil 40,000 gallons daily. It will be conducted twelve miles into a reservoir above the town, and earn a water rate of two pence per gallon, as against four pence, the present rate. Galvanized pipes are unpopular, as the zinc dissolved is thought to aggravate any inclination to suffer from fever.

Kerosene oil engines are used, owing to the scarcity of water and the improbability of ever pumping water four hundred miles from the ocean. They are used to drive stamp mills. The Akroyd and Priestman types are employed principally, and their use will probably soon extend to tramway haulage. The district itself is in an embryo state, struggling hard to get out of the shell with the aid of British capital. Although gold is being produced, it is the speculator who is doing the most effective work.

"The routine of gold-mining operations at Coolgardie is familiar to anyone who recollects Wynaad in the years 1880-81; only it is being repeated on a much larger scale. Briefly, a class of mineral viewers exists in Australia who are generally fitted out with camp equipment, and have their expenses paid by syndicates at Melbourne, Adelaide, and Sydney, who raise a capital of about one thousand pounds at a time. These viewers examine the wilds, and, on finding payable quartz, peg out a claim of say forty acres for each member of a search party, which is surveyed and registered as the property of the syndicate, under the mining act of the colony. The syndicate have then to keep a man on nominal work upon each claim as long as they wish to retain a title. Just now wages amount to £4 per man weekly, and, with any other work incidental, there is a heavy unproductive outlay, till machinery which may cost £10,000 is erected by a powerful company. The next process is to enlarge the syndicate into a regular mining corporation, and dispose of the whole property on the reports of mining experts to a new company with directors in London, and whose shares are quoted on the stock exchanges. In the case of Wynaad, it may be remembered, those companies were formed right and left, and shares rose and fell long before a stock of machinery had time to reach the ports of India, still less get transported up the Western Ghats, and crush any gold.

"There are computed to be 20,000 people on the Coolgardie Goldfields; wages are £4 a week per man, and the lowest cost of ordinary living about £2-10-0 a week, while the monthly outturn of gold is only 14,000 ounces, worth £53,000, from all the few mines now working combined, or a quarter of the bare subsistence of the population. The problem is from what source—be it London or the savings of Sydney, Melbourne, and Adelaide—the rest of the brisk expenditure undoubtedly going on is derived."

Etching Tests for Iron and Steel.

THE following observations are described in *The American Manufacturer* (Feb. 7) as being originated by Professor Kick, of Prague. The metal is first highly polished, then immersed in 1.062 specific gravity muriatic acid until the etching is plainly visible, washed in water, brushed, and finally washed in dilute spirits of salammoniac; after drying, rusting is prevented by means of a thin coat of clear gum-lac. The characteristic tests are:

"*Soft or fibrous forge iron.* If it is of excellent quality, it will be attacked uniformly, even if the action of the acid has lasted for several hours; defective places and ash holes make their appearance. The cauterized surface appears bright and of weak lustre. '*Fine grain' iron.* The conduct is similar to that above. The cauterized surface appears still more uniform, but darker.

"*Coarse grain or cold short iron* is attacked more sharply than the kinds mentioned before. The surface becomes black very soon on account of the strong separation of carbon; after the acid has acted about ½ hour the coal can be washed off as a black slime; the exposed surface remains black even then. The surface is uneven and corroded, which can be observed plainly, when the metal is dried after about one hour's cauterizing and the file is applied slightly to the cauterized surface.

"*Puddle steel.* The color of the cauterized surface is a rather uniform gray.

"*Bessemer and cast steel* are attacked quite uniformly; defective places are found but rarely, and these do not show off to any great extent. The color is gray and increases in brightness with increasing softness of the steel. Fine fissures become visible after cauterizing.

"*Pig iron, cast iron and gray pig iron* conduct themselves similar to steel; the color of the cauterized surface is a uniform dark gray."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

3571. Cost of Copper Production. Ed. E. & M. J. (Editorial reply to twenty-two questions on vital points in the copper industry, covering detailed costs and items of interest to those commercially interested in copper). Eng & Min Jour–Jan. 11. 3900 w.

*3596. The Mechanical Testing of Iron and Steel. Professor Hudson Beare, in *Science Progress* (A scientific paper). Col Guard–Jan. 3. 4800 w.

†3605. A Proposed Schedule of Allowable Difference and of Probable Limits of Accuracy in Quantitative Analyses of Metallurgical Materials. E. D. Campbell (A valuable contribution giving, in tabular form, the variation usually allowed, and the limit of accuracy due to method, of all the substances usually determined in metallurgical work). Jour Am Chem Soc–Jan. 400 w.

*3631. Notes on the Treatment of Tailings by the Cyanide Process at the Standard Consolidated Mines, Bodie, California. Thomas H. Leggett (Paper read before the Inst. of Mining and Metallurgy. Detailed statement of time required, quantities, and values involved in the process are given, including cost of treatment, supplies consumed and value of products). Min Jour–Jan. 4. 400 w.

3641. Red Plastic Fire Clay. Charles Ferry (The writer states that a small percentage of iron oxide may be beneficial, as it makes the brick hard and tough). Ir Age–Jan. 16. 1600 w.

3642. The Troy Basic Bessemer Steel Plant (An illustrated description of the plant which is being built on a similar plan to the Pottstown, Pa., basic Bessemer plant). Ir Age–Jan. 16, 1000 w.

3655. Ore Treatment—Cyanide and Chlorination. W. P. Harvey (Giving interesting results obtained by both processes in the United States, and stating that the ores of British Columbia must be treated by these methods). Min & Sci Pr–Jan. 11. 2300 w.

*3669. The Extraction of Zinc from Its Ore. Henry W. Nichols (A general detailed description taken from the *Chicago Mining Review*). Aust Min Stand–Nov. 30. 1700 w.

3703. The Acetylene Mystery (Criticism of the claims of the various acetylene companies, especially on the cost of producing calcium carbide). Eng & Min Jour–Jan. 18. 2500 w.

3705. Special Device for the Elevating of Granulated Slag (A method of removing furnace slag. It is granulated by being run into water, raised by a special basket elevator and carried off in a sluice). Eng & Min Jour–Jan. 18. 400 w.

3729. Hamilton Smelting Works (Illustrated description of a new iron furnace plant). Can Eng–Jan. 1800 w.

*3731. Spontaneous Combustion of Coal (A discussion of the causes leading to the phenomenon with recommendations as to how this pyrophoric tendency of stored coal may be counteracted). Col Guard–Jan. 10. 900 w.

*3740. The Cyanide Process of Gold Extraction—Discovered 43 Years Ago. J. C. Montgomerie (Showing why the patents held should not be valid). Aust Min Stand–Dec 14. 1800 w.

*3741. The Preparation and Properties of Molybdenum. H. Moissan (From the *Bulletin de la Société de l'Encouragement de l'Industrie Nationale.* Description of method of making soft metallic molybdenum and also the carbide). Aust Min Stand-Dec. 14. 700 w.

*3743. Dry Crushing and Royalty (Considerations affecting the adoption of fine crushing and cyanide treatment of the entire mine output. 60% is estimated as being won by amalgamation at present in South Africa). Aust Min Stand–Dec. 14. 1200 w.

*3745. Remarks and Observations on the Cyanide Process. Walter J. Studds (Experiments on the effect of the addition of different alkalies to cyanide solutions, the extraction varying from 15 to 93 per cent). Aust Min Stand–Dec. 21. 1600 w.

3763. Treatment of Low Grade Ore. Edmund B. Kirby (Considerations which determine what process of ore treatment shall be selected for any given ore). Min & Sci Pr–Jan. 18. 3000 w.

3806. A Model Tin Plate Plant (Description of the Laughlin Nail Co.'s works, illustrated by three views of the machinery, and one plan). Met Work–Jan. 25. 900 w.

*3820. Microscopic Internal Flaws in Steel Rails and Propeller Shafts. Thomas Andrews (Attributing the failure of steel forgings when subjected to repeated stress to cavities filled with sulphide of iron, which are really microscopic flaws. The three sections shown illustrate this plainly). Engng–Jan. 17. 1600 w.

3869. The Kinkead Waste Rock Experiment (Illustrated description of a newly designed plant to treat waste gold ore from the dumps of a California mine. The ore treated runs about $4 per ton in gold). Min & Sci Pr–Jan. 25. 800 w.

3911. Semet-Solvay Retort Coke Ovens, with Recovery of By-Products. R. M. Atwater (From a paper read before the meeting of the Ohio Inst. of Min. Engs. Comparison of the Beehive oven coke with the Semet-Solvay product, with results of working). Ir Tr Rev–Jan. 30. 5000 w.

*3941. Burning Powdered Coal (Description, illustrated by two views, of the automatic feed used in a powdered coal furnace). Col Guard–Jan. 24. 1000 w.

*3942. Economic Conditions of the Iron and Steel Industry in Belgium and Germany (The official report just issued of the commission appointed by the British Iron Trade Assn. to investigate the comparative labor and industrial conditions on the continent). Col Guard–Jan. 24. 5000 w.

4006. The Smelting of Titaniferous Ores. A. J. Rossi (The general considerations, methods of treatment, and the properties of titanic minerals are fully discussed). Ir Age–Feb. 6. Serial. 1st part. 4200 w.

4042. The Amalgamation of Rich Free Gold-Ores. F. Hille (Relative economic results of ball-mill and mortar amalgamation in Transylvania. The former was run at about 1-10 the expense of the latter). Eng & Min Jour–Feb. 8. 1000 w.

4055. Open-Hearth Practice in Germany (A recent improvement, designed to evenly distribute the current of gases, consists of a transverse middle division wall in the regenerators). Ir Tr Rev–Feb. 6. 700 w.

4073. How to Distinguish Between the Different Kinds of Iron and Steel (Method of preparing specimen, and the appearance of the polished surfaces of each grade when etched with acid). Am Mfr & Ir Wld–Feb. 7. 700 w.

Mining.

3572. The Question of Extra-Lateral Rights. A. H. Wethey (A discussion of Court decisions, having the plan of claims and workings illustrated). Eng & Min Jour–Jan. 11. 2400 w.

*3614. The Loop Creek, West Virginia, Coal Field. Daniel W. Langdon (Its history, nature of the coal, how mined, its analyses, physical features). Col Eng–Jan. 1000 w.

*3667. The Mount Lyell Mining and Railway Company, Limited (Description embodying the report of the mine manager, engineers and metallurgists). Aust Min Stand–Nov. 30. 6000 w.

3702. The World's Greatest Gold Field. Dan de Quille (General review of the California gold fields). Min Ind & Rev–Jan. 16. 1400 w.

3711. The Methods of Prospecting for Gold in the South. William M. Brewer (Methods used in determining the extent of the deposits, and considerations affecting the method of mining and treatment of ore). Tradesman–Jan. 15. Serial. 1st part. 4400 w.

*3733. Periodicity of Fire-damp. A. Doneux (The writer states that fire-damp explosions follow sympathetically the hebdomadal fluctuation, and that it obeys the law of volcanic action). Col Guard–Jan. 10. 1800 w.

*3734. The Adhesive Properties of Coal. M. Louis Campredon (Brief extract from a paper read before the Académie des Sciences, Paris, on the relative coking properties of coals). Col Guard–Jan. 10. 500 w.

*3738. Mining Accident Relief Fund (A scheme to provide for accidents to miners). Aust Min Stand–Dec. 7. 600 w.

*3739. Deep Level Mines. L. J. Seymour (Some notes on the Lake Superior copper mines). Aust Min Stand–Dec. 7. 3300 w.

*3742. The Underground Workings of Broken Hill Block 10 Silver Mine (Illustrated description from the report of the general manager). Aust Min Stand–Dec. 14. 1900 w.

*3744. Physiography and Geography of the Wadnaminga Gold Fields, South Australia. F. D. Johnson (Paper read before the Australian Inst. of Min. Engs. An extended description). Aust Min Stand–Dec. 14. Serial. 1st part. 3400 w.

*3746. The Principles and Practice of Mining and Ore Dressing on the Zeehan Field. E. Moriarty Weston (An excellent description of practice in Tasmania). Aust Min Stand–Dec. 21. 4000 w.

*3747. Mount Bischoff Tin Mine (Tasmania) (Description with illustrations of the Red Face and the Brown Face workings). Aust Min Stand–Dec. 21. 500 w.

†3765. The Coolgardie Gold Fields, West Australia. A. T. F. (A true description of this much talked of Western Australian district, by one who has been there. Illustrated by a map). Ind Engng–Dec. 21. 2200 w.

3779. Mexican Mining Operations Creating a Market for American Machinery. E. L. (Information as to the situation and character of some of the principal mines in Mexico). Mfrs Rec–Jan. 24. 1300 w.

3788. 100-Ton Derrick at the Avondale Marble Quarries, Chester, Pa. (Illustrated description of derrick and method of working quarry). Eng. News–Jan. 23. 800 w.

3809. Camp Floyd District, Utah. James W. Neill (The gold production of the Mercer and adjoining districts is $2750 daily). Eng & Min Jour-Jan. 25. 2800 w.

3810. The Salt Creek Oil Field, Wyoming. Wilbur C. Knight (A description with seven illustrations. The probable production in 1896 is put at 5000 barrels). Eng & Min Jour-Jan. 25. 1200 w.

*3826. The New Perforators. Ill. Léon Thiriart (A paper read before the Assn. of Min. Engs. at the Liège School, and translated from *La Revue Universelle des Mines, de la Métallurgie, &c.* These screw feed drills are intended to displace power drilling and blasting in fire damp coal mines). Col Guard-Jan. 17. 2500 w.

3904. The Oriskany Iron Ores at Rich Patch Mines, Va. Edmund C. Pechin (General description). Eng & Min Jour-Feb. 1. Serial. 1st part. 1400 w.

3910. Wire Rope Haulage, Its Use and Abuse. T. E. Hughes (Read at Columbus, O., before the Ohio Inst. of Min. Engs. The author points out the superiority of standard over long lay wire ropes and the influence of friction on the life of the rope, with some notes on haulage systems). Ir Tr Rev-Jan. 30. 2400 w.

*3940. Water Cartridges in Blasting. L. Jaroljmek (Water is used as tamping and acts at the same time on the quicklime termination of the dynamite cartridge, generating sufficient heat to fire the fulminate cap). Col Guard-Jan. 24. 2000 w.

3957. The Trail Creek Gold Mining District of British Columbia. J. D. Sword (General description). Can Min Rev-Jan. 4500 w.

†4000. The Mines and Plant of the El Carmen Mining Company, Villaldoma, Mexico. Harrison Souder (A description of the silver mines, sampling the ore, ventilation of the workings, water supply, and the company railroad. The article is well illustrated). Pro of Eng's Club of Phila-Jan. 5000 w.

4015. The Auriferious Gravels of British Columbia. J. M. Buxton (Some mining experiences in working the British Columbia hydraulic gold deposits). Mining-Jan. 2000 w.

4016. The Slocan Country. Charles F. Caldwell (Brief notes on existing mines in this district of West Kootenay, B. C). Mining-Jan. 2200 w.

4017. Hallidie Ropeway at Halls Mines, Nelson, B. C. Ill. (A steel cable ropeway, carrying ore four and one-half miles, carrying 900 traveling buckets, holding 100 lbs. each. The system is automatic). Min & Sci Pr-Feb. 1. 700 w.

Miscellany.

†3606. An Electrolytic Method for the Determination of Mercury in Cinnabar. W. B. Rising, and Victor Lenher (The cinnabar is dissolved in hydro-bromic acid, neutralized with caustic potash, pure cyanide of potash added in excess to dissolve precipitate, and the metallic mercury deposited on platinum by a weak electric current). Jour Am Chem Soc-Jan. 400 w.

3615. Norwegian Minerals Containing Thorium and Yttrium. L. Schmelck (These minerals are important by reason of the incandescent properties of their oxides). Am Mfrs & Ir Wld-Jan. 10. 800 w.

3656. Balance Sheet of a South African Mine (Itemized official statement). Min & Sci Pr-Jan. 11. 200 w.

*3668. Suggestions as to Building a Mill (Considerations affecting the location of a stamp mill). Aust Min Stand-Nov. 30. 800 w.

3704. The Transvaal Crisis (Short history, with portraits of the principal actors in the Transvaal—viz.: Messrs. Kruger, Rhodes, Williams, Barnato, Jameson, and Hammond). Eng & Min Jour-Jan 18. 1300 w.

*3730. Mineral Resources of Spain. Reginald W. Barrington (A condensed description). Ind & Ir-Jan. 10. Serial. 1st part. 800 w.

*3737. Geology of Central Australia (Description of explorations made by the South Australian government geologist, with special reference to mining deposits). Aust Min Stand-Dec. 7. 2300 w.

*3748. The Origin of Malachite. Edgar Hall (Observations in an abandoned copper mine leading to a theory of formation of copper carbonates). Aust Min Stand-Dec. 21. 1300 w.

3764. Venezuela, Its Industry, Mining and Commerce. I. B. Storch (The mineral deposits are undeveloped, as prospecting, owing to the dense underwood, is difficult. The annual production of gold was 180,000 ounces). Min & Sci Pr-Jan. 18. 900 w.

3808. The Transvaal Troubles (A condensed statement of the causes leading to the revolt and notes on the present situation. A readable editorial). Eng & Min Jour-Jan. 25. 2300 w.

*3825. The Mineral Industry of the United Kingdom (First annual general report upon the mineral industry). Col Guard-Jan. 17. Serial. 1st part. 5500 w.

†3907. The Building Stones of the United States. Dr. William C. Day (Distribution, methods of quarrying and general characteristics of the stones produced at present for structural purposes). Jour Fr Inst-Feb. 6000 w.

*3935. "That Flood of Gold." Carl Snyder (Popular, interesting description of methods in modern gold mining, with remarks upon probable effect of the great increase in gold production). Rev of Rev-Feb. 4000 w.

†4064. Topography, Climate, and Mineral Springs of Alabama. A. N. Bell (The article contains analyses of a number of the mineral waters of the state and a complete list of the springs; also facts in relation to the advantages of the state as a winter resort). San-Feb. 2400 w.

†4070. The Precipitation of Phosphomolybdate in Steel Analysis. George Auchy (Experiments tending to prove that dilute solutions and the presence of ammonia nitrate are essential conditions for complete precipitation). Jour of Am Chem Soc-Feb. 1000 w.

MUNICIPAL ENGINEERING

Determination of Nitrites in Water.

CERTAIN discrepancies (very marked in the case of peaty waters) having been found to exist between Trommsdorff's iodo-zinc starch method and Griess's *a*-napthylamine test upon a large variety of waters, Mr. Augustus H. Gill, conjointly with Mr. H. A. Richardson, has contributed to *Journal of the American Chemical Society* for January a method of decolorizing peaty waters so that agreement between these standard tests is obtained.

"The peaty waters showed no blue by Trommsdorff's method, but in some cases as high as 0.001 parts nitrogen as $N_2 O_3$ per 100,000 by the Griess test. Upon decolorizing the waters, the results agreed, showing that the peaty matter interferes with the formation of the iodid of starch, and, unless nitrites are present in considerable quantity (above 0.002 parts nitrotrogen as $N_2 O_3$ per 100,000), this test is not capable of detecting them.

"The decolorization was effected in the cold, as heating increases the nitrites, by shaking up about 250 cc. of the water with three cc. of 'milk of alumina' (prepared by precipitating a boiling solution of potash alum with ammonia, etc.), allowing to settle, and filtering through a filter which is washed free from nitrites. Even when using Griess's method, it was found advantageous to decolorize the peaty waters, as their brown color modifies the pink tint, giving a slightly higher reading than would otherwise be obtained."

A table given by the author shows the effects of the peaty matter, and also a comparison of the methods, together with that of the *m*-phenyldiamine, which table is not in convenient form for reprinting in this review. With reference to the results the author says further:

"In some cases a pink color was obtained and no blue, due probably to the greater delicacy of the naphthylamine test, it being competent to detect 0.0001 parts of nitrogen as $N_2 O$ in 100,000. This, we think, is the extreme limit of the test, as different shades, not *depths*, of color are obtained upon adding different quantities of the reagents, as Dr. J. T. Tanner found. The iodo zinc starch method is incapable of detecting less than 0.0002 parts of nitrogen as $N_2 O_3$ per 100,000.

"In a few cases the blue color appeared, but no pink; but, upon passing carbon dioxid through the water, no blue was obtained. This may possibly have been due to hydrogen peroxid. Where large quantities of nitrites are present, a purple color, instead of a blue, is obtained, which is difficult to estimate; in such cases the water should be diluted before applying the test.

"In conducting the Griess test, the directions given by Dr. Tanner were followed, with the additional precaution of using water free from nitrites in the preparation of the reagents. This was prepared by distilling the middle portion of ordinary distilled water with an excess of alkaline permanganate, collecting the middle portion of the distillate thus obtained. Water prepared in this way gives no test upon eighteen hours' standing, even when tightly stoppered."

Computation Table for Flow in Sewers.

MR. ANDREW ROSEWATER, member of the American Society of Civil Engineers, and city engineer of Omaha, writes to *Engineering News* (Jan. 16), that references made to certain features of the city reports for 1893-4 have resulted in a multitude of applications for copies, which cannot now be supplied, as the edition is exhausted.

One of the features which excited the demand was a table for computing flow in sewers. In order that it may be made as widely available as possible, Mr. Rosewater sent the table to the *Engineering News*, which reprinted it, together with the letter accompanying it. In furtherance of the same object, we too herewith reprint this useful table, with an explanation whereby its application can be easily understood.

Method of using the table:

Table of Velocity and Discharge of Circular Conduits Based on Kutter's Formula, n. equals .013 Grade equals 1 in 100 (or s equals .01).

Diam. of Conduit. Ft.	In.	Veloc. in ft. per sec.	Disch. in cu. ft. per sec.	Diam. of Conduit. Ft.	In.	Veloc. in ft per sec.	Disch. in cu. ft. per sec.
	4	1.81	0.16	7	0	16.98	653.4
	6	2.52	0.49		3	17.37	717.2
	8	3.17	1.11		6	17.77	785.1
	9	3.47	1.53		9	18.12	854.7
	10	3.77	2.05	8	0	18.50	930.0
1	0	4.34	3.40		3	18.87	1008.9
	3	5.12	6.29		6	19.25	1092.4
	6	5.87	10.37		9	19.57	1177.1
	8	6.35	13.85	9	0	19.94	1268.6
	9	6.57	15.79		3	20.29	1363.7
	10	6.80	17.94		6	20.65	1463.7
2	0	7.24	22.74		9	20.96	1565.0
	2	7.67	28.27	10	0	21.31	1673.7
	4	8.08	34.53		3	21.65	1786.2
	6	8.48	41.64		6	21.99	1903.9
	8	8.88	49.59		9	22.28	2022.7
	10	9.26	58.63	11	0	22.62	2149.6
3	0	9.63	68.09		3	22.94	2280.5
	2	10.00	78.78		6	23.27	2417.0
	4	10.36	90.39		9	23.56	2554.3
	6	10.71	103.00	12	0	23.88	2700.5
	8	11.05	116.80		3	24.50	2850.8
	10	11.39	131.50		6	24.50	3007.0
4	0	11.73	147.40		9	24.77	3163.6
	2	12.07	164.50	13	0	25.09	3329.9
	4	12.39	182.70		3	24.19	2850.8
	6	12.71	202.20		6	25.69	3677.3
	8	13.01	222.40		9	25.95	3854.3
	10	13.31	244.20	14	0	26.25	4041.9
5	0	13.62	267.50		6	26.84	4432.2
	2	13.94	292.10	15	0	27.39	4839.9
	4	14.23	317.80		6	27.95	5274.5
	6	14.535	345.10	16	0	28.48	5726.8
	8	14.78	373.00		6	29.03	6208.4
	10	15.07	402.80	17	0	29.55	6707.1
6	0	15.36	434.30		6	30.08	7236.3
	3	15.78	484.20	18	0	30.58	7783.1
	6	16.20	537.70	19	0	31.59	8958.4
	9	16.57	593.10	20	0	32.58	10236.0

To find the velocity and discharge of a 3 ft. 8 in. sewer on a 2.25% grade. Find the velocity and discharge as given in the table opposite 3 ft. 8 ins. and multiply them by the square root of 2.25.

Thus 11.05 multiplied by 1.5 equals 16.57, the required velocity.

Thus 116.8 multiplied by 1.5 equals 175.20, the required discharge.

When the velocity and discharge are desired for different values of n than (n equals .013), very good approximate values can be deduced as follows:

For n equals .011, multiply tabular quantities by 1.20.

For n equals .012, multiply tabular quantities by 1.09.

For n equals .015, multiply tabular quantities by 0.84.

Table of Grades per 100 and their Square Roots.

Grade per 100.	Square Root of Grade.	Grade per 100.	Square Root of Grade.	Grade per 100.	Square Root of Grade.
.04	.200	1.20	1.095	3.15	1.775
.05	.224	1.25	1.118	3.20	1.789
.06	.245	1.30	1.140	3.25	1.803
.07	.265	1.35	1.162	3.30	1.817
.08	.283	1.40	1.183	3.35	1.830
.09	.300	1.45	1.204	3.40	1.844
.10	.316	1.50	1.224	3.50	1.871
.11	.332	1.55	1.245	3.60	1.897
.12	.346	1.60	1.265	3.70	1.924
.13	.361	1.65	1.285	3.80	1.949
.14	.374	1.70	1.304	3.90	1.975
.15	.387	1.75	1.323	4.00	2.000
.16	.400	1.80	1.342	4.20	2.049
.17	.412	1.85	1.360	4.40	2.098
.18	.424	1.90	1.378	4.60	2.145
.19	.436	1.95	1.396	4.80	2.191
.20	.447	2.00	1.414	5.00	2.236
.22	.469	2.05	1.432	5.20	2.280
.24	.490	2.10	1.449	5.40	2.324
.26	.510	2.15	1.466	5.60	2.366
.28	.529	2.20	1.483	5.80	2.408
.30	.548	2.25	1.500	6.00	2.449
.35	.592	2.30	1.517	6.50	2.550
.40	.632	2.35	1.533	7.00	2.646
.45	.671	2.40	1.549	7.50	2.739
.50	.707	2.45	1.565	8.00	2.828
.55	.742	2.50	1.581	8.50	2.915
.60	.775	2.55	1.597	9.00	3.000
.65	.806	2.60	1.612	9.50	3.082
.70	.837	2.65	1.628	10.00	3.162
.75	.866	2.70	1.643	11.00	3.317
.80	.894	2.75	1.658	12.00	3.464
.85	.922	2.80	1.673	13.00	3.606
.90	.949	2.85	1.688	14.00	3.742
.95	.975	2.90	1.703	15.00	3.873
1.00	1.000	2.95	1.718	16.00	4.000
1.05	1.025	3.00	1.732	17.00	4.123
1.10	1.049	3.05	1.746	18.00	4.243
1.15	1.072	3.10	1.761	20.00	4.472

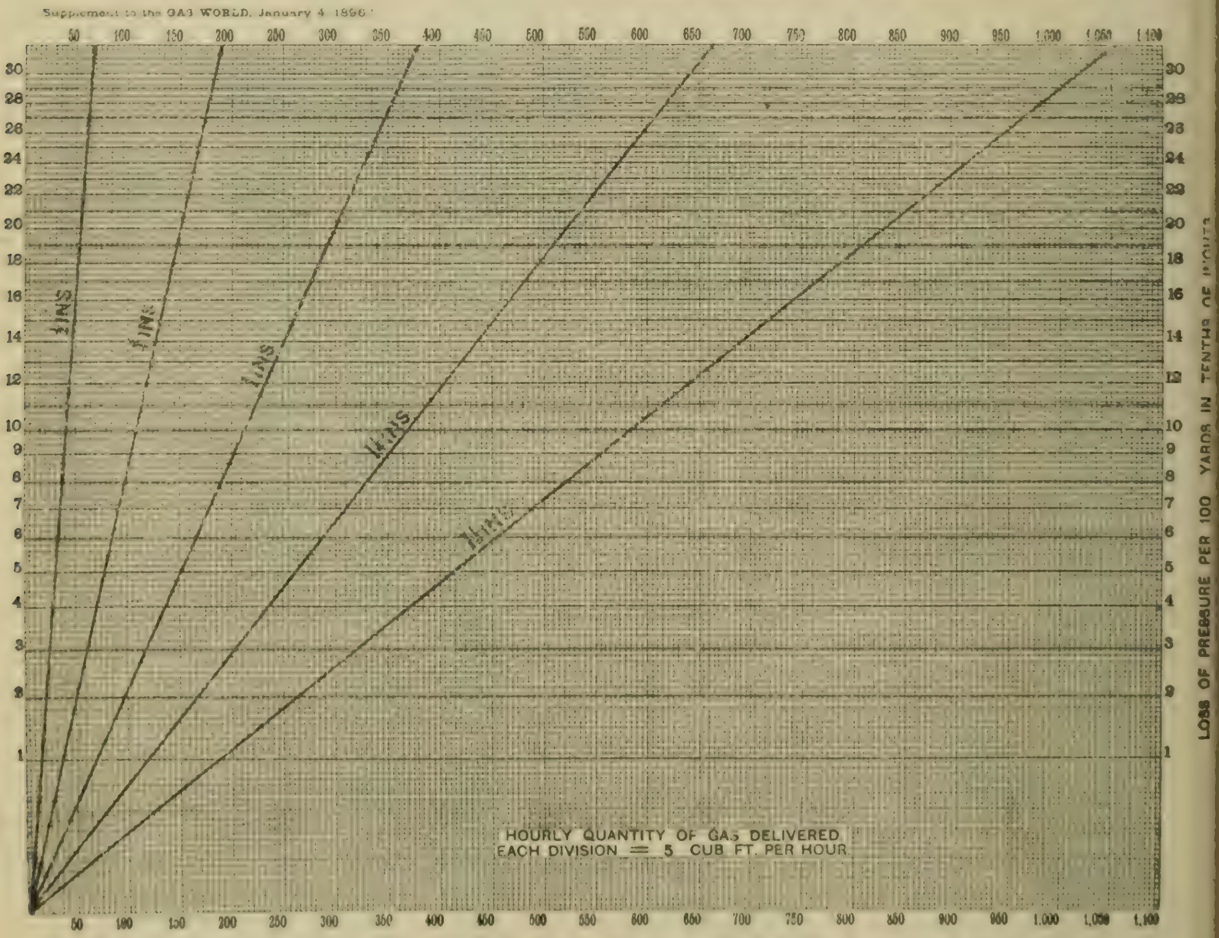
For n equals .017, multiply tabular quantities by 0.73.

These can be used with a limit of error of 10%, and it is only in the extreme cases where the error exceeds 5%.

The above approximations give excessive values for small diameters and insufficient values for large diameters.

Delivering Capacity of Gas Mains.

THE determination of the delivery of gas through mains has hitherto involved a considerable amount of calculation. Mr. Lewis T. Wright has contributed to *The Gas World* a series of diagrams,—the first of which is herewith reproduced,—whereby the flow can be determined without the labor of calculation. The diagram thus presented enables the flow of gas having a specific quantity 0.4 to be determined for service pipes of ¼, ½, 1, 1¼, and 1½-inch diameter.



LEWIS T. WRIGHT'S DIAGRAMS SHOWING DELIVERY OF GAS BY PIPES AND LOSS OF PRESSURE AT POINT OF DISCHARGE—**No. 1.**

It is not our intention to present the other diagrams for larger sizes of pipes in this department, as they will appear subsequently in *The Gas World*, but, as they are useful and of interest to gas engineers, we call attention to them in this review.

The following explanation will render easy the general application of the diagrams:

"The vertical lines show the hourly quantity of gas delivered. The horizontal lines show the loss of pressure per 100 yards in the case of diagrams 1 and 2, and per 1,000 yards in the case of Nos. 3 and 4 and 5, in the complete set of five diagrams. The inclined lines represent the pipes or mains, according to their diameters in inches.

"Though these diagrams are drawn for fixed distances of 100 and 1,000 yards, respectively, they are readily available for any distance in the following manner: the maximum loss of pressure that can be allowed for any given distance having been decided upon, it is easy to calculate the loss per 100 or 1,000 yards. Thus, if the allowable loss of pressure be 20 tenths for a distance of 2,000 yards, the loss per 1,000 yards will be 10 tenths, and the loss per 100 yards will be 1-tenth, because the loss of pressure is proportional to the distance."

When the maximum quantity of gas to be delivered, the distance to which it is to be transported, and the maximum loss of pressure, are known, the diagram will give at a glance the size of pipe that will meet the requirements.

By these diagrams, also, the loss of pressure may be found when the size of the main, the quantity of gas delivered, and the length of main are given; and, when the length of main, its diameter, and the loss of pressure are known, the quantity that will be delivered may be as readily ascertained.

The diagrams will be useful also to those who are installing gas engines of considerable size.

The Carbid of Calcium Industry.

DR. W. H. BIRCHMORE in *Engineering News* (Jan. 30) has contributed the most able essay upon carbid of calcium, in its relation to the future of gas lighting, that we have met. As to the Wilson and the Morehead patented methods, he thinks "it would be an amusing result if an attempt, which will surely be made, to overthrow the Wilson patent should result in making the manufacture free to all the world." And he states that "it is now the opinion of practically all patent lawyers who have examined the question that the Wilson patents are waste paper." The following quotation from Dr. Birchmore's paper is significant.

"The more this substance is studied, the more plainly it appears that there is room for much yet to be learned concerning the manufacture. Many are the scientific and practical problems involved, as has been demonstrated in repeating the experiments of all interested, from Wohler to Moissan. I beg leave to affirm that, in addition to the CaC_2 union, there are certainly others, and one of them seems to be more frequently produced by the Cowles process than by the Wilson. Incidentally it may be mentioned that a number of pounds of alleged carbid made by the Cowles process came into my hands, which would yield neither ethine, methane, nor hydrogen. Still more singular were some of the vagaries of the samples made in North Carolina by the Morehead connection."

With reference to the mode of preparation he says: "In all the patents issued to Wilson is shown a furnace which is identical in all respects with the classic Siemens type, and in the articles in the *Gas Light Journal* the same appears. It is the Siemens furnace with a part of his drawing left out and the balance disfigured; the electric governing apparatus is omitted. The implied purpose is to show the way in which carbid is manufactured. Now, in point of fact, there has not been one pound of carbid made in this way, and in the judgment of some lawyers, and good ones at that, the performances of the Morehead connection in using and exhibiting, as a commercial process of making carbid, a method not protected, and trying to sell the same, has brought in conditions surrounding the problem that will make plenty of trouble for the 'innocent purchaser' after the latter has made carbid a commercial success. In the method in actual use there is no crucible, but an open hearth in which the material is piled and subjected to the current; and, as the center of the pile melts under the heat, pieces of boiler iron are set about so that the pile may be built higher.

"The rapid cooling at the surface makes a column of fused amorphous carbid with a crystalline center in the midst of a heap of uninfluenced lime and coke, built up between two vertical electrodes, one of which is constantly retreating. To call this an operation protected by the Wilson patents exposes one to contradiction.

"Be this as it may, I, personally, in laboratory experiments, have made carbid as follows: (a) by the Wilson patent method; (b) by the Morehead patent practical unpatented method; (c) in a furnace using Cowle's methods of working; (d) by the Clarke patent methods; (e) by the unpatented method of Moissan; and from these studies I have found that modifications of Moissan's multiple arc furnace will produce the carbid even more cheaply than the Morehead method."

The paper concludes with the following significant paragraphs:

"There are two directions in which improvements can be made. The burners can be improved so that, in place of a consumption of 1.4 cu. ft. and a 64-c. p. (B P.) unit, a consumption limited to 0.43 cu. ft. and 20-c. p. unit shall be reached. This would instantly bring the value of a ton of carbid up to the promoter's figures, and make the Morehead h. p. value 4.48 cts. per h. p. hour. At the same time an increase in the efficiency of the furnaces to say 80%, which is, I am told, the efficiency of the Herault process, would raise the product to 27 lbs. per h. p. day at the dynamo.

"Either one of these improvements would put ethine in the market as a rival for coal gas, electric lighting, and even the common kerosene oil lamp.

"More than a dozen expert men are working on these problems, and any day the much-wanted burner may come to hand, and with it a revolution in the financial status of those who will doubtless appreciate the advantage of being first in a commercial field.

"Once given a burner which will burn ethine properly, and carbid industries will spring up all over the country, without any bubble-blowing or professional promotion. There will not only be a carbid industry, but a great many carbid industries."

MR. L. L. BUCK, chief engineer of the new East River Bridge to connect New York and Brooklyn says that if trolley cars are to be used on the bridge as has been proposed, they must, under present conditions, be run singly, or with motor cars and four trailers. This service would be inadequate during crowded hours, and hence the engineer thinks that two tracks in the direction of travel would be needed. He thinks the best arrangement would be placing two elevated road tracks in the center and two trolley tracks on each side of them. This would make six tracks in all. It is thought that with this arrangement proper cross-overs can be made for each set of tracks, and that it will undoubtedly afford all the facilities needed for a long time.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

*3563. A Retrospect of the Year 1895 (Review of the gas industry for the year). Jour Gas Lgt–Dec. 31. 4700 w.

*3566. Coal Carbonizing in Bulk at Lancaster (Treats of the system of coal carbonizing in bulk, with recovery of all products and with special reference to a plant installed at Lancaster, a view of the works being also given. An instructive and interesting article). Jour Gas Lgt–Dec. 31. 2500 w.

*3567. A Spectroscopic Study of Oxy-Coal Gas (An investigation by M. Jean S. Stas). Jour Gas Lgt–Dec. 31. 1100 w.

*3589. The Delivering Capacity of Gas Mains (Diagrams for blow of gases of different specific gravities). Gas Wld–Jan. 4. 1100 w.

3674. Calcic Carbide Plant at Niagara Falls. Ill. Orrin E. Dunlap (The product of this initial plant will be sent to Philadelphia in barrels and there manufactured into acetylene gas to supply southern Pennsylvania). W Elec–Jan. 18. 1200 w.

3728. Calcium Carbide and Acetylene (Additional information about the substances, and the industrial results likely to proceed from the discovery of the Wilson process of making calcium carbide). Can Eng–Jan. 2500 w.

†3802. Gaseous Compounds of Iron and Nickel with Carbonic Oxide and their Curious Effects on Burner-Tips, etc. Henry Morton (Causes of the mushroom shaped deposits on burner tips experienced in the use of water gas, and their chemical composition). Stevens In–Jan. 1200 w.

*3835. Destructive Distillation. R. Tervet (Paper read before the Scottish Soc. of Chem. Ind. Discusses the subject from the standpoint that no matter to what extent a crude distillate may vary in the relative proportions of its ingredients, it always has a destructive character). Gas Wld–Jan. 18. 2400 w.

†3844. Acetyline (The story of the discovery, with some consideration of its value). New Sci Rev–Jan. 1300 w.

3857. Some Facts About Acetylene Gas. John C. McMynn (Read before the Northwestern Electrical Assn., Milwaukee. Followed by an abstract of the discussion). Elec Rev–Jan. 29. 3000 w.

3882. Acetylene Gas (An abstract of an article on this subject appearing in the *N. Y. World* of Jan. 26, with brief notice of a paper on the same subject by Prof. Crafts). Elec Wld–Feb. 1. 2000 w.

3884. Calcium Carbide and Acetylene (Editorial, commenting on the commercial methods by which these products are sought to be introduced, and upon views of experts regarding them). Engng News–Jan. 30. 2200 w.

3886. Will there Be a "Carbide" Industry? Dr. W. H. Birchmore (Opinions of a well known expert. The history of the chemistry of calcium carbide and acetylene is given and the five different methods of producing carbide of calcium are reviewed, two only of which are patented.

The history of the present acetylene boom is also given. Methods of using the material and its properties are discussed, and the Wilson patents are declared simply waste paper so far as their protection of the monopoly of manufacturing calcium carbide is concerned. The extreme probability of a revolution in gas lighting by the supply of needed improvements in the manufacture of calcium carbide, and the supply of a proper burner for it, is admitted). Engng News -Jan. 30. 5000 w.

*3891. The Effect of Atmospheric Conditions on the Hefner and Pentane Standard Lamps (Atmospheric conditions noted as adversely effecting the illumination of the lamps named are presence of moisture and carbonic acid, diminution of atmospheric pressure, and diminution of oxygen. Experiments to determine quantitatively these effects are described, and the results are given). Jour Gas Lgt–Jan. 21. 3000 w.

4036. Acetylene (Objections to use of acetylene in the liquid form). Eng Rec–Feb. 8, 500 w.

Sewerage.

3610. Sewer Excavating Machinery (Illustrated detailed description). Eng Rec–Jan. 11. 500 w.

3654. A Table for Computing Flow in Sewers (A very useful table with description of method of applying it). Eng News–Jan. 16. 600 w.

*3832. Sewage Disposal at Salford (General description with sketch plan). Eng, Lond–Jan. 17. 2300 w.

4037. A Portable Sewer-Flushing Apparatus (Illustrated description of apparatus used in New Haven, Conn., whereby work that used to require from eight to ten days is now performed in two or three hours). Eng Rec–Feb. 8. 900 w,

4038. The Sewer Outfall at Ithaca, N. Y. Ill. An interesting example of cheap and easily constructed work, designed by Mr. Rudolph Hering). Eng Rec-Feb. 8 400 w.

Streets and Pavements.

3995. Comparative Value of Side Cut, End Cut and Repressed Brick for Street Paving. T. C. Tridell (Advantages and disadvantages of each class. A good, practical paper). Brick–Feb. 1300 w.

*3997. Recent Discussions of Asphalt (General review of some of the latest literature of the subject). Pav & Mun Eng–Feb. 2500 w.

Water Supply.

*3564. Water and Sanitary Affairs (The principal events of the year 1895). Jour Gas Lgt–Dec. 31. 3000 w.

3575. The Reading, Pa., Water Supply (The first part is historical and statistical with brief references to two sources of present supply). Fire & Water–Jan. 11. Serial. 1st part. 1300 w.

†3604. Notes on the Determination of Nitrites in Potable Water. Augustus H. Gill, and H. A. Richardson (The presence of peaty matter having caused discrepancies in the results obtained by Trommsdorff's iodo-zinc starch method, and Griess' a-naphthylamine test, this article formulates a method whereby peaty waters may be decolorized, and the results of the two tests thus made accordant). Jour Am Chem Soc–Jan. 400 w.

3657. Cedar River Gravity Water Supply for the City of Seattle, Washington (History of the enterprise). Min & Sci Pr–Jan. 11. 1500 w.

3699. Consumption and Waste of Water. Dexter Brackett (A paper read at the annual convention, and reprinted from the Trans. of Am. Soc. C. E. Detailed statistics and general remarks. Causes and prevention of waste also considered). Eng Rec–Jan. 18. Serial. 1st part. 2000 w.

*3866. On the Bacterial Contents of Certain Ground Waters Including Deep Wells, Boston. W. T. Sedgwick (Describes experimental investigations of numerous springs, wells and deep wells, with reference to their containing germs of bacteria. Results show the water from wells and springs may contain more bacteria than water from lakes). San Rec–Jan. 17. 2200 w.

*3892. The Municipal Water Supply of Cologne (Illustrated detailed description of an interesting subject. Elevation and plan of boiler-house and pumping station are given in first part). Jour Gas Lgt–Jan. 21. Serial. 1st part. 2200 w.

†4069. Chemical vs. Bacteriological Examination of Potable Water. W. P. Mason (The depreciation of chemical examination in favor of bacterial, is criticised as having gone too far, and it is maintained that while both methods are valuable, there are cases depending upon special conditions, in which either of these methods might be more reliable than the other). Jour of Am Chem Soc–Feb. 800 w.

Miscellany.

†3561. Sewerage and Street Cleaning of Vienna. Max Judd (From report to State Department. An interesting description of means and methods). San–Jan. 2000 w.

*3593. The Bath Refuse Destructors. (Illustrated detailed description). Engng–Jan. 3. 1300 w.

3637. Municipal Art Again (Editorial, treating of the improper expenditure of money that ought to contribute to the beauty of a city). Gar & For–Jan. 15. 1200 w.

*3841. Notable Sanitary Experiments in Massachusetts. W. T. Sedgwick (The work accomplished by the State Board of Health of Massachusetts, chiefly in the direction of water supply and sewerage). Forum–Feb. 6500 w.

4018. The First Calcic Carbide Plant. Orrin E. Dunlap (Illustrated description of the works recently erected at Niargara Falls for the manufacture of calcic carbide). Min & Sci Pr–Feb. 1. 1300 w.

4023. The Johnson Garbage Crematory (Illustrated description of the experimental crematory at Chicago, Ill., with an account of its performance in recent tests. The expense of cremation has been found to be 28.2 cents per ton). Eng News–Feb. 6. 1000 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

Emergencies in Railroad Work.

To the *Bulletin of the University of Wisconsin, Engineering Series* (Dec.), Mr. L. F. Loree contributes a very interesting lecture on his personal experiences in railroad wrecks, washouts, strikes, etc. After describing the equipping of wreck trains, their provisioning, and the character of the emergencies to be met, he continues, quoting the practice of the C. & P. division of the Pennsylvania Railroad Company as follows:

"We have found it convenient to have a crew consisting of a foreman and twelve men. These men are employed about the shops where the car is kept, and work at car repairs. Should one, for any reason, desire to absent himself from his duties, permission is first obtained of the foreman, who designates another to fill the vacancy, so that a full complement of men is always assured. Should the wreck occur during working hours, the crew is advised of it by whistle signal; if at night, by electric bells located in their homes.

"There is a similarity between the service of the wreck train and that of a city fire department. The value of the service is greatly dependent upon the quickness with which the apparatus is got on the ground. So, when the signal sounds, every man hastens to his place; the most available engine and crew are pressed into the service, regardless of their previous engagements; once started, they are given a clear track to the point of obstruction; other trains scurry in on the lie-bys, very much as travelers seek the sidewalks and teams the curb as the ringing of the fire gong announces the approaching truck. Arriving at the wreck, a telegraph office is hooked up, the train wire cut in, and communication established with headquarters. A man is left in charge of the tool car, who issues the tools as they are called for, and cleans and puts them away in order as they are returned. He also keeps the coffee-pot boiling and serves up a luncheon of biscuits, tinned meats, etc. Again, as at a fire the chief effort is to prevent its spread, so here the effort is not so much to save the damaged cars as to clear the line for the movement of traffic. Nearly everything is rolled down the bank; the picking up is postponed to a more convenient season or the all-accommodating Sunday. Meantime, much has been done in other directions. The party calling for assistance is required to supplement his call with a description in some detail of the situation, and an estimate of the probable time required to clear. If this be more than four hours, no more freights are despatched from terminals, but effort is concentrated upon marshalling trains and clearing up the yard tracks to take care of the concentrated movement which must follow the resumption of business. If the estimate is for less than four hours, the trains are moved up as close as possible to the wreck, and so put away on the sidings that, when the movement is resumed, the knot will easily untie. Meantime arrangements are making for detouring mail trains over foreign lines, and around the obstruction, or for transferring by the same from train to train. Altogether there is a fine activity, which is but feebly set out in the records of the C. & P. Division, from which I have compiled the following tables.

AVERAGES OF TIME, 1890 to 1894.

No. times called, day	33
" " " night	22
Time between call and start, day	15 min.
" " " " " night	24 "
" running to wreck	36 "
" in cleaning away wreck	2 h. 2 "

Minimum time between call and start.

Year.	6 a. m. to 6 p. m.	6 p. m. to 6 a. m.
1890	5 min.	13 min.
1891	2 "	8 "
1892	3 "	8 "
1893	5 "	5 "
1894	5 "	13 "

Speaking of the efficient manner in which the railroads handled the strike in 1894, the author concludes: "Whether we regard the action of their management, dignified in the maintenance of their rights, disdainful of compromise with the wrongdoer, steadfastly holding their course through this troubled sea; or the conduct of their men, moving in small and isolated groups, quietly and indomitably, to the performance of their duties, amid the howlings of the mob,—there stands revealed an institution and a spirit that may well give heart to them that love the Republic when any similar movement threatens the destruction of established order."

Mileage of European Railways.

THE opinion has been expressed that the United States has built all the railways that will be needed. However this may be, Europe, with its network of operating lines, still finds it necessary to add to this means of transportation. In *The Railway Age* (Nov. 15.) will be found the following official information:

"The bureau of railways of the French government has published a statement of the railway mileage in each country in Europe on the 31st of December, 1894, with comparions for the previous year, from which, as printed in *Le Journal des Transports*, we obtained the following figures, after converting kilometers with miles:

COUNTRY.	Miles of Railway.	Increase in 1894.
Germany	28,317	469
Austria-Hungary	18,662	545
Belgium	3,445	44
Denmark	1,408	22
Spain	7,547	442
France	24,738	385
Great Britain and Ireland	20,863	224
Greece	568	.....
Italy	9,087	274
Netherlands	1,657	4
Luxembourg	260	......
Portugal	1,456	3
Roumania	1,603	5
Russia	20,699	1,212
Finland	1,383	87
Servia	335	......
Sweden	5,737	280
Norway	1,068	67
Switzerland	2,160	33
Turkey, Bulgaria, and Roumelia	1,248	119
Isles of Malta, Jersey, and Man	68	......
Total	152,209	4,212

"While railway building continues in the old and finished countries, it certainly is not likely to cease in this new land, with vast areas still poorly supplied with transportation facilities. Even the percentage of increase experienced by Europe last year would have given this country over 5,000 miles, instead of the little more than 2,000 miles which were credited to 1894,—the period of smallest construction in about thirty years. The rate of increase last year in Turkey and its provinces was 1.05 per cent., in Finland 6.70 per cent., in Russia 6.22 per cent., in France 6.22 per cent., in Sweden 5.14 per cent., in Italy 3.11 per cent., in Austria-Hungary 3.01 per cent., while in the United States it was only 1.23 per cent.,—a remarkable contrast to previous records, and a contrast which is not likely to be often repeated."

Apropos of the above, and as showing the state of American railroad construction, we quote the following from *The Railway Age* (Dec. 27):

"The rapid decrease in railway building in the United States in the last years may be seen by the following figures from our record of actual construction:

1887	Track	laid,	12,983	miles.
1888	"	"	7,106	"
1889	"	"	5,230	"
1890	"	"	5,670	"
1891	"	"	4,281	"
1892	"	"	4,192	"
1893	"	"	2,635	"
1894	"	"	1,949	"
1895	"	"	1,782	"

"The bottom has been reached, and a moderate revival of railway building may be looked for. Materials are exceedingly cheap, labor is abundant, practical enterprises are numerous and on some of them much work has been done, business is reviving in spite of terrific assaults from political and speculative quarters, and the needs of many localities for greater transportation facilities must be met. It is true that the remarkable development of electric railway building has had a repressive effect upon not a few local projects; but for transportation lines of any considerable importance the steam locomotive does not yet recognize any competition, and the building of steam railways is still to go on, although the pace of former years may not again be equaled.

"The railways of the United States on December 31, 1895, will aggregate a little over 181,000 miles."

Roadbed Construction for Street Railways.

FROM an article appearing in the *Street Railway Journal* (Jan.) on the present practice in street railway work, we extract the following comments, with cuts representing the present typical forms of road-bed construction:

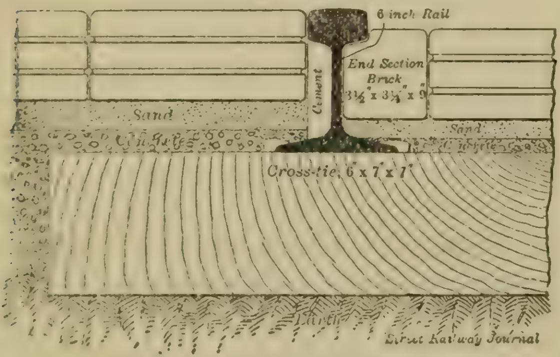


FIG. 1.—T RAIL ROADBED.

"The old horse railway track construction, with its flat, side-bearing rails spiked down to longitudinal stringers, has gone by forever. In its place have come forms of construction which almost equal in solidity the standard roadway construction of our best steam railroads. With the latest and best forms of street railway track construction, we are confidently looking for a life of at least eight or ten years before complete renewals will become necessary through pounding down of joints, rotting of ties, or wearing away of the head of the rail.

"The use of concrete as a substructure for track construction is not as general in America as abroad, although in the principal cities of Canada and a few in the United States it has been used with excellent results, giving much greater solidity and permanency to the track than where the foundation is the natural dirt, gravel, or clay.

"Wooden ties are reasonably plentiful and cheap in the United States, and are generally used instead of metal ties, which, however, have been recently adopted in Detroit, Terre Haute, and a few other cities, chiefly in the west. The ties are usually placed close together, rarely exceeding two-foot, or two-and-a-half-foot centers. Creosote and other preservative compounds are rarely used, it being the general opinion that the life of the tie will be at least as long as that of the rail, but not of double length, so that, in relaying roadbed, it would not be advisable to put new rails on old ties, even if the latter were in fairly good condition. Gravel or broken stone is the usual ballasting material employed, the latter being more generally used in interurban lines and the former in the city streets, where the street foundations are well packed together and reasonably solid.

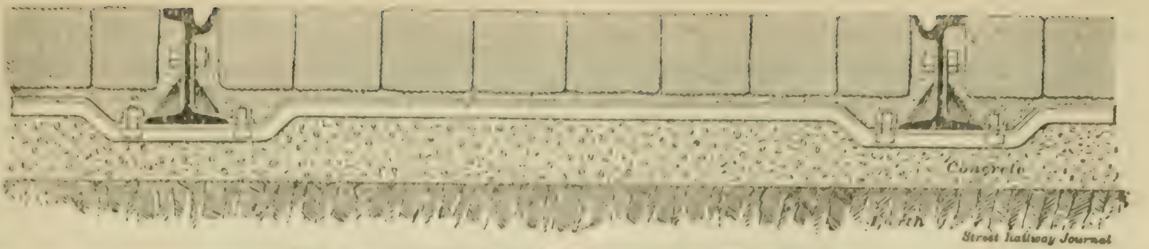
"The manufacture of girder rails for street railway purposes has become an enormous industry in the United States within the past six or seven years. It is estimated that the output of all our mills has, in the last ten years, amounted to nearly or quite 1,000,000 gross tons, and the present annual product is over 160,000 tons. Originally, there were several patented processes of making these rails, and the cost was placed considerably above the price of ordinary steel T rails, but within the last five years the price has dropped, until purchases can now be made at substantially T-rail prices."

Long-Distance Electric Transmission.

A GOOD example of one of the questions which may come up in any large electric road installation is treated in the *Street Railway Review* (Dec. 15). The editor introduces his comparison of central and auxiliary stations as follows:

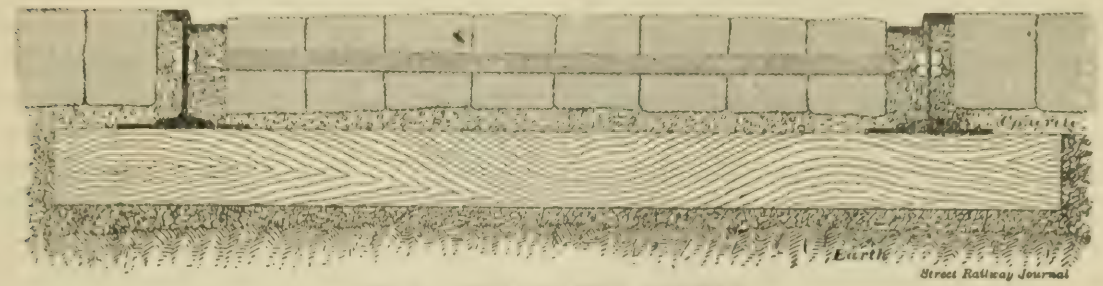
"Now that transmission at pressures of 5,000 to 10,000 volts has become an assured electrical success, it is fitting for the electric railway engineer to inquire what bearing this new fact may have on his future work. It is not sufficient to the practical man to read of the possibility of transmitting large amounts of power long distances. He wants to know where and to what extent long-distance transmission at high pressures is commercially profitable.

"The only way to determine with accuracy as to whether centralized or subdivided power is the cheaper is to calculate



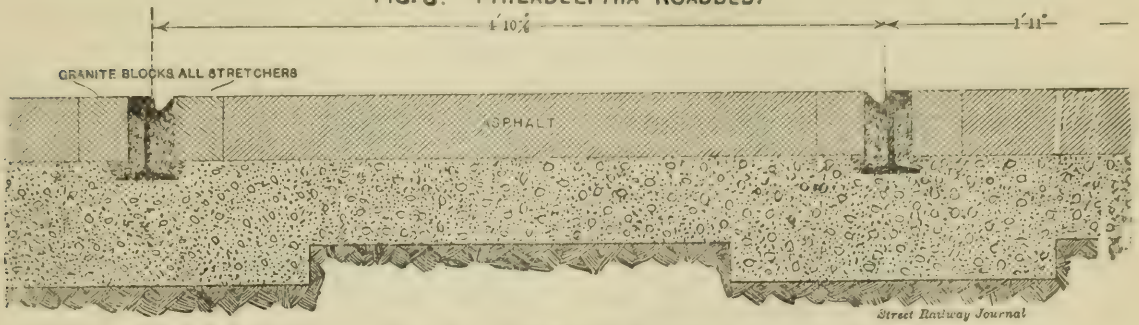
Street Railway Journal

FIG. 2. —DETROIT ROADBED, WITH METAL TIES.



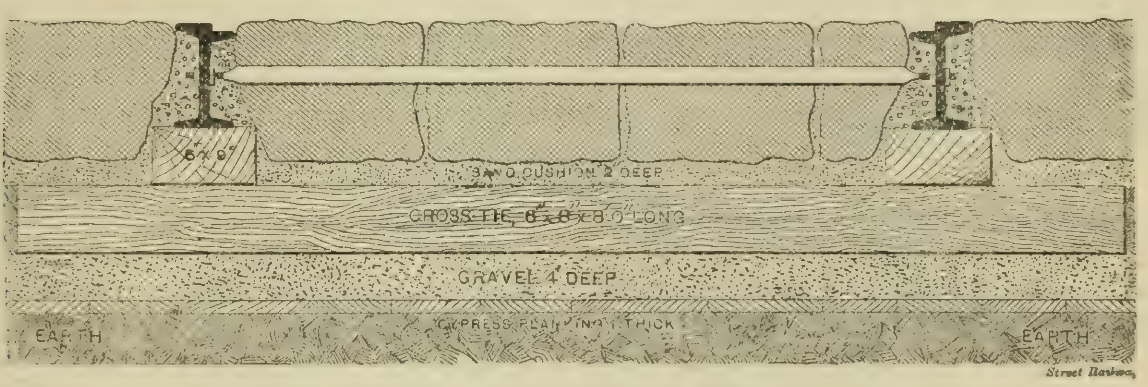
Street Railway Journal

FIG. 3. —PHILADELPHIA ROADBED.



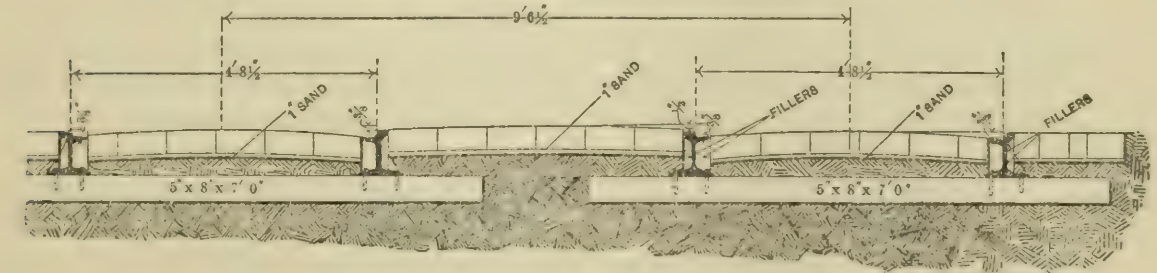
Street Railway Journal

FIG. 4. —TORONTO ROADBED.



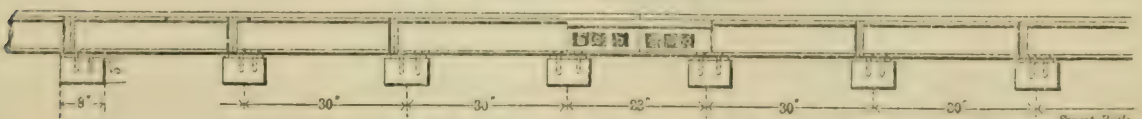
Street Railwa

FIG. 5. —NEW ORLEANS ROADBED.



Street Railway Journal

FIG. 6. —CHICAGO ROADBED, 1895



Street Railw

FIG. 7. —CHICAGO ROADBED.

every specific case. General rules can not be laid down which will cover all conditions. In order to give some idea of the commercial possibilities and limitations of high-pressure transmission, let us select a set of conditions which is likely to exist in the near future in several places. Assume that there is already in operation a large power plant supplying a city system, with machinery for the most economical production of power and with adequate provision for extension at a minimum expense. Assume now that fifteen miles away another division of road is to be built, which will require a maximum of 300 h. p. Will it be cheaper to build another power station to supply that division rather than transmit at high pressure from the big plant?"

To enlarge the central plant so as to be able to deliver 300 h. p. at the sub-station trolley bus will require a long-distance transmission under 5,000 volts pressure (allowing 10 per cent. loss), and a two phase circuit, as follows:

Steam plant at central station; 360 h. p.	$18,000
Generators at central station; 270 k. w.	5,400
Copper in lines	11,232
Step up transformers; $14 per k. w.	3,780
Step-down "	3,780
Rotary transformers; 224 k. w.	4,480
Sub-station building, etc.	1,000
Total	$47,672

The average losses in transmission will be about as follows: line, 5 per cent.; step-up transformers, 2 per cent.; step-down transformers, 2 per cent.; rotary transformers, 10 per cent.; total, 19 per cent. To deliver 150 horse-power average load to the trolley feeders at the sub-station with 19 per cent. loss requires 185 horse-power average at the central station. The fuel for the loss of 35 horse-power 20 hours a day will cost, under the foregoing conditions, $1,177 a year. The sub-station will require the services of two men, one for each watch. For comparison, then, the yearly operating expenses and fixed charges on the transmission system are as follows:

Interest on $47,672 at 6 per cent.	$2,860
Cost fuel lost in transmission	1,177
Two men at $60 per month	1,440
Total	$5,477

Suppose now a steam plant is to be erected at the sub-station location to do the same work. The small separate steam plant will cost more per horse-power than the addition to the large one. Assuming that it will cost $10 per horse-power more than a corresponding addition to the large steam plant, 300 horse-power at $60 per horse-power will amount to $18,000. Generators (224 kilowatts at $20 per kilowatt) will be $4,480. The cost of installing the separate plant is, therefore:

Steam plant	$18,000
Generators	4,480
Building, etc.	3,000
Total	$25,480

The yearly operating expense for comparison with such a plant is about as follows:

Interest on $25,480 at 6 per cent.	$1,528
Two men at $80 per month	1 920
Two men at $50 per month	1,200
Total	$4,648

Thus, under the above assumptions, the subdivided seems cheaper than centralized power generation. However, the matter will bear a little closer inspection. In making these calculations, it has been necessary to assume numerous conditions, and a change in one or two of these may throw the balance on the other side. Thus, if 10,000 volts were used instead of 5,000, there would be a reduction of three fourths in the amount of copper required, and the use of the three-phase system would reduce this still more, making a reduction of over $500 in fixed charges on the copper investment. Then, too, if coal was cheap,—say $1, instead of $2, per ton, as it is in many places,—the loss in transmission in this case would be reduced over $600 per year. This would make the centralized power production the cheapest.

"In spite of the modifications that the foregoing figures must undergo when applied to specific cases, it is evident that, unless changes are made from any existing railway transmission practice, conditions must be very favorable if a large interurban system can be operated cheaper by one large central steam plant transmitting power at high transformed voltages than by small steam plants in each district. In any case the investment will be much greater for the transmission system than for the small stations." The hope for the future seems to lie in a successful alternating-current railway motor, with its high possible potential, absence of commutators and transformers, and great economy.

Illumination Tests.

In order to determine the best light to be used in the Lehigh Valley Railroad coaches, Col. R. H. Wilbur, general superintendent of the road, caused a series of tests to be made by two experts, Professor W. H. Chandler and Professor J. E. Denton, of the best available lights. The results of these tests have been noticed in technical journals, and we deem them of sufficiently practical value to warrant us in quoting as follows from the original exhaustive and accurate report obtained through the courtesy of Professor Chandler:

"One of the 18.7 cu. ft. cylinders under chair-car No. 10 was charged with city gas at about seventeen atmospheres pressure, and another with Pintsch gas, under about eight and a half atmospheres, and tested during the nights of October 3 and 4." The lamps tested were of the Pintsch Argand and the Gordon-Mitchell Argand types, each used with both city gas and Pintsch gas alternately. The tests were made with the utmost care, the lamps being placed in the usual position in the car by representatives of the companies furnishing the lamps, who also acted as two of the four observers who made readings of the photometer in each test, the other two observers being Mr. Spanutius of Lehigh University, and either Prof. Denton or Prof. Jacobus of Stevens Institute." The disc of the photometer was about six inches square, hung in a hole in the heavy curtain screen by an axis permitting its surface to be presented directly to any of the lamps in front of it. Observations were made at four angles. The standard candles were calibrated by weighing and applying the appropriate corrections to the candle power obtained. Observations were taken with four lamps, and also with one lamp, burning.

"Our conclusions from the four-lamp data, with both lamps 40¾ inches above the centre of the photometer disc, are as follows:

"1. The Pintsch lamp with Pintsch gas averaged 1.583 times as much light as the G. M. lamp with Pintsch gas, and the latter consumed 1.003 times as much gas. Hence, for equal illumination, the G. M. lamp consumed 1.59 times the amount of gas required by the Pintsch lamp.

"2. The Pintsch burning Pintsch gas averaged, for the four angles, 1.76 times as much light as the same lamp with city gas, and the latter consumed 2.2 times as much gas. Hence, for equal illumination, the Pintsch lamp consumed 3.87 times as much city gas as it did of Pintsch gas.

"3. The Pintsch lamp with Pintsch gas averaged 1.555 times as much light as the G. M. lamp with city gas, and the latter consumed 2.21 times as much gas. Hence, for equal illumination, the G. M. lamp consumed 3.44 times the amount of gas required by the Pintsch lamp.

"4. The G. M. lamp with city gas averaged 1.13 times as much light as the Pintsch lamp with city gas, and consumed 1.006 times as much gas. Hence, for equal illumination, the Pintsch lamp consumed 1.11 times the amount of city gas required by the G. M. lamp."

The above "general illumination tests" were designed by Prof. Chandler and elaborated by himself and Prof. Denton. The following is the tabulated statement of tests with single lamps;

Lamp.	Kind of gas burned.	Average candle-power per cu. ft of gas burned.	Relative amount of gas required per hour for equal illumination. Ratio.*	$\frac{1.00}{\text{Ratio.*}}$ Gas consumed for equal illumination, as compared with the Pintsch lamp with Pintsch gas.
Pintsch lamp.	Pintsch	15.9	1.00	1.00
" " .	City	4.4	3.61	0.277
Gordon-Mitchell	City	3.6	4.42	0.226
	Pintsch	7.5	2.12	0.472

$$\text{* Ratio} = \frac{\text{Candle-power of Pintsch burner with Pintsch gas} = 15.9}{\text{Candle-power of Pintsch burner with city gas and G. M. burner with both city and Pintsch gas.}}$$

General Conclusions.—" The average of the results from both the single lamp tests, and the general illumination tests in which both lamps were at the same distance from the photometer, afford the following general conclusions :

" The useful illuminating power of the Pintsch Argand lamp in a car burning Delaware and Lackawanna Railroad Pintsch gas at the rate of 3.3 cu. ft. per hour is 3.73 times the amount which is afforded per cu. ft. by the same lamp burning compressed Jersey City water gas at the rate of 7.2 cu. ft. per hour ; 1.71 times the amount afforded per cu. ft. by the Gordon-Mitchell lamp burning Pintsch gas at the rate of 3.3 cu. ft. per hour ; and 3.92 times the amount afforded per cu. ft. by the Gordon-Mitchell lamp burning compressed Jersey City water gas at the rate of about 7.2 cu. ft. per hour."

The relative economy will be brought out in a later report ; of course, this will depend largely upon the location and source of supply.

THE MAXIMUM FLEXION POINT IN AXLES was the title of a paper by Mr. Thomas Andrews, receiving the " Bessemer Premium " for 1895. *The Railway Review* (Feb. 15) abstracts the following : " Briefly, all the experiments coincided in indicating an increase of rigidity or brittleness of railway axles under the influence of the different kinds of stress and strain applied, the extent of the increase of rigidity being found to vary according to the nature of the metal, the condition of temperature and the species of the strain. The effects of stress were found to be similar, whether produced by slow flexion, impact shocks, torsional, tensile, or other strain. The result also showed that the greater the stress to which the metal was subjected the greater was the increase of rigidity and consequent deterioration of its physical properties. Steel axles, both Bessemer and Siemens, were shown to increase in rigidity and consequent deterioration under concussional shocks more than wrought iron ones. That railway axles at a temperature 100 degrees Centigrade, take a similar more extensive reduction of flexion endurance at 300 degrees Centigrade was a further important result of the research. This fact afforded a strong indication of the increased danger to railway axles arising from overheated railway axle journals or necks during running."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

3597. Some Pennsylvania Locomotives and Fast Runs (A detailed description with speed diagram and profile of road from Jersey City to Philadelphia. Average speed 57.60 miles per hour. Full details are given of the locomotive performance). Ry Age–Jan. 10. 900 w.

†3603. The Railroad from Tien-Tsin to Shan-Hai Kuan (History of the beginning and progress of railroading in China, and of the road named in particular). Consular Reports–Jan. 2700 w.

3607. The Genesis and Progress of a Great Railroad System.—The Boston & Maine (The history of the route from the first stage route in colonial times to the present system. It is of considerable general interest). Ry Rev–Jan. 11. Serial. 1st part. 2800 w.

3608. Alignment Improvements on the Pennsylvania Railroad (A section of double track tunnel is given). Ry Rev–Jan. 11. 600 w.

3617. Increased Railway Earnings in 1895 (These statistics are given for each road and classes of roads for 1894 and 1895. It is a very detailed statement showing the increase in 1895 to be 5.2%). Bradstreet's–Jan. 11. 1400 w.

3619. The Street Railway Systems of Brooklyn (Illustrated description). Elec Ry Gaz–Jan. 4. Serial. 1st part. 1800 w.

3620. The Relation Between Stress and Sag in Span and Trolley Wires. E. A. Merrill (Special attention is called to points having particularly to do with the initial cost, especially in iron pole construction). Elec Ry Gaz–Jan. 4. 1700 w.

3621. A Glance at the Situation. Keppele Hall (Reviewing the various methods of street railway propulsion, and commenting on points for improvement, etc). Elec Ry Gaz–Jan. 4. 1700 w.

3622. A Decade of Progress (Electric traction in the last ten years). Elec Ry Gaz–Jan. 4. 800 w.

3623. Inspection of Electrical Rolling Stock. Charles F. Uebelacker (Criticising the number of methods, and making suggestions). Elec Ry Gaz–Jan. 4. 1200 w.

*3626. Brixton Cable Tramway (The largest cable road in Great Britain. The plant and equipment are fully described and illustrated). Ry Wld–Jan. 6. 400 w.

*3627. Composite-Corridor Carriages of the Great Western Railway (Cars containing separate compartments for first, second, and third class passengers and luggage-room in each carriage). Ry Wld–Jan. 250 w.

*3628. Locomotives for the Snowdon Rack Railway (A mountain locomotive, working on a gradient of 1 in 5½. It is of Swiss construction and has many interesting features). Ry Wld–Jan. 1200 w.

*3629. Light Railways: Their Construction and Working. William Rose Smith (This class of construction is well defined and its application in Mexico, Holland, Italy, Prussia, Belgium, Ireland and America described). Ry Wld–Jan. 4000 w.

3640. The High Speed Brake. R. A. Parke (From a paper read before the New England Railroad Club. Description of a quick acting brake used on the Empire State Express). R R Car Jour–Jan. 1000 w.

†3645. Emergencies in Railroad Work. L. F. Loree (A lecture delivered before the students of University of Wisconsin. Treating of wrecks, strikes, and organization). Bul of Univ of Wis–Dec. 11500 w.

3647. Repair of Electric Railway Apparatus. Ill. W. E. Shepard (This series of papers will give an outline of the various branches and departments connected with the operating side of electric street railway work. The aim will be to give some hints and suggestions in choosing, constructing and repairing railway apparatus and for guidance in the general routine of the maintenance department which may prove to be of assistance to the mechanic, foreman or superintendent having such work in hand). Elec Ind–Jan. Serial. 1st part. 1200 w.

3661. Air Brakes on Freight Cars (A discussion in the Western Railway Club of the paper by A. M. Waitt). R. R. Gaz–Jan. 17. Serial. 1st part. 3600 w.

†3665. Axles (A series of tests on railway axles, conducted at Sheffield, Eng., by the proprietor of the Worthy Iron Works). Ind & East Eng–Dec. 14. 2200 w.

*3715. Cost of Track Laying (Itemized estimated cost of six sections of road-bed and track for street railways. Each section is illustrated, and the article is valuable throughout). St Ry Rev–Jan. 15. 2500 w.

*3716. The Protection of Drawbridges (Suggestions as to methods designed to prevent street cars from running into open draws). St Ry Rev–Jan. 15. 1000 w.

*3719. Electric Railway Express. A. L. Stone (Illustrated description of equipment, showing how loaded wagons are carried on flat-top cars). St Ry Rev–Jan. 15. 700 w.

*3736. The Awakening of the Great Western (Some notes on the fast time made by the express trains on this road; average, 50 miles per hour. The time and distance table is given showing the average time between stations). Engng–Jan. 10. 1200 w.

*3753. Electric Power for Railroads. Harris J. Ryan (A review of the advance of electricity for railway purposes during the past year. In following numbers the writer will give a review of the engineering methods now in use for electric railroads and discuss those that will probably be given a trial in the near future). Sib Jour of Engng–Jan. 1300 w.

3766. The Electric Cable Railway of the Stanserhorn, in Switzerland (Illustrated description from *La Nature*). Sci Am Sup–Jan. 25. 2200 w.

†3774. Sleepers (Editorial discussion of the various types of railway ties and sleepers employed in India). Ind & East Eng–Dec. 21. 1400 w.

3775. Railroads in Massachusetts (The Annual Report of the Board of Railroad Commissioners. It is of considerable interest). R R Gaz–Jan. 24. 1500 w.

3776. Parlor Cars for an Electric Railroad (An up-to-date departure in Brooklyn, N. Y. The cars are finely upholstered, the details being represented in the accompanying illustrations). R R Gaz–Jan. 24. 400 w.

3777. Runaway Trains on Elevated Railroads (An editorial showing that such accidents are not due to any fault in design of the equipment). R R Gaz–Jan. 24. 2200 w.

3778. Preserving Timber with Woodiline (The method is described and advantages stated). R R Gaz–Jan 24. 1800 w.

3784. Revision of the M. C. B. Interchange Rules (The rules include specific instructions to inspectors, repair men, for billing cars and miscellaneous matters. It constitutes the report of the "Committee of Twenty-one" and is open to revision). Ry Rev–Jan. 18. 4000 w.

3785. An Air-Tight Dummy Coupling. Ill. (A compound air-brake coupling used on the Michigan Central R. R. possessing advantages that have led to their replacing angle cocks on engines). Ry Rev–Jan. 18. 600 w.

3786. The Cost of Railway Trains (The value of a regular train is about $50,000, and an ordinary passenger coach costs as much as a comfortable home, or half as much as a locomotive). Ry Rev–Jan. 18. 700 w.

3787. Oil Fuel for Locomotives—Los Angeles Terminal Railway (This description is interesting in view of the extreme saving effected over the cost by using California coal). Ry Rev–Jan. 18. 1000 w.

3800. The Transportation Problem in New York City (The editor thinks the present transportation systems overcrowded, but says the free spirit of Americans will rebel at any underground transportation scheme, and further that easy transportation induces increased traffic). Sci Am–Jan. 25. 1600 w.

*3829. Steam Locomotives on Common Roads. W. Fletcher (Description of various designs and uses to which they are put). Eng, Lond–Jan. 17. Serial. 1st part. 3300 w.

3838. The Hauling Capacity of Locomotives. H. H. Vaughan (Abstract from a paper read before the Northwestern Railway Club. A valuable article, both practical and theoretical). Ry Rev–Jan. 25. 2700 w.

3839. Air Brake Equipment on Freight Trains (Discussion upon paper on same subject, an abstract of which was published in this journal on Dec 14. It deals with the trouble some roads have had with the freight air brake). Ry Rev–Jan. 25. 1800 w.

3848. The Fastest Railroad Run Ever Made. Ill. Harry Perry Robinson (Distance 510 miles—average running time 65.07 miles an hour—highest speed attained 92.3 miles an hour). McClure's Mag–Feb. 5500 w.

*3851. The Dublin-Dalkey Electric Tramway. Ill. (One of the most interesting features of this system consists in the adoption of power transmission by means of polyphase currents, between the power house and the two sub-stations which feed the line en route. Descriptive). Elect'n–Jan. 17. 2500 w.

*3854. The Coventry Electric Tramway System (Illustrated description). Elec Rev, Lond–Jan. 17. 2800 w.

3867. Some Information from Indicator Cards. D. (A series of six cards is given which were taken from locomotives, and they illustrate the work in the cylinder very clearly under different conditions). R R Gaz–Jan. 31. 1200 w.

3868. A Costly Track for Hard Service (The elaborate equipment at the Grand Central terminal is described, with special reference to steel ties and rail fastenings). R R Gaz–Jan. 31. 1400 w.

†3894. Indian Railway Provident Institutions (Discussion of the system which insures a railway employee a competence upon being retired from service). Ind Engng–Dec. 28. 1500 w.

*3895. Cercovado Railway, Brazil. Lewis Gleason (A well illustrated description of a rack railway up the side of Mt. Cercovado, which overlooks Rio de Janeiro. The engine is of Swiss manufacture and the grade from 16 to 25 per cent). Loc Engng–Feb. 1000 w.

*3900. Agreements, Contracts, Specifications, Installation and Repairs. W. H. Elliott (The author shows exactly what should be included under the given headings in the installation and operation of a signal system. Crossings, signal-towers and interlocking are given special attention). Loc Engng–Feb. 5000 w.

†3916. The Mt. Snaefel Railway, Isle of Man (A well illustrated description. A third rail in the center line of the track prevents derailment and in cases of emergency is clutched by a grip brake). St Ry Jour–Feb. 400 w.

†3917. Conduit Electric Railways. A. N. Connett (Notes on the operation of the Ninth Street Line of the Metropolitan Railroad Co., Washington, D. C. The operating expense per train (motor car and trailer) mile was about 8 87 cents). St. Ry Jour–Feb. 1700 w.

†3918 Power Distribution for Electric Railroads. Louis Bell (A thoroughly technical article, illustrated by diagrams). St. Ry Jour–Feb. 4000 w.

†3919. Truck and Motor Repairs (An itemized statement showing that the repairs of gear wheels are 56% of the total number of repairs with a cost of 59% of the total cost of repairs). St Ry Jour–Feb. 600 w.

†3920. Electric Street Railway Tracks. R. J. McCarty (Three methods of laying ties on broken stone mixed with sand. The one proposed will cost $1736 per mile of single track road-bed). St Ry Jour–Feb. 1300 w.

†3921. The Doom of the Cable in San Francisco. S. L. Foster (Illustrated description of method used to convert over half a mile of cable road into a trolley line of wider gauge, in seven days). St Ry Jour–Feb. 1500 w.

†3922. Club House for Motormen and Conductors (The street railway at Derby, Conn., has converted one of its buildings into a club house containing bath, dining-room, reading-room, pool and billiard room and gymnasium. The scheme proposes to bring the employees into closer relation to the company). St Ry Jour–Feb. 700 w.

*3938. Notes on Russian Engineering. Charles Hyde (Abstract of a paper read before the Engs. Soc. of W Penna. The points touched are both detailed and interesting). Am Eng & R R Jour–Feb. 3700 w.

*3945. Old Great Southern and Western Railway Locomotives (Eighteen diagram illustrations of some peculiar types with plans and sections of firebox). Eng, Lond–Jan. 24 300 w.

†3967. Discussion of Air Brake Equipment (Discussion by the members, of a paper read by Mr. Waitt. The opinions expressed are valuable, as they come from those engaged in practical railroad operations). Pro West Ry Club–Dec. 15500 w.

†3968. Locomotive Service. J. H. M'Connell (An interesting paper on the growth, economy in operating, hauling capacity, and work of locomotives. The author thinks the engines should be loaded more heavily). Pro W Ry Club–Dec. 2000 w.

4024. Statutory Regulation of Interlocking Signals for Railway Grade Crossings (Historical summary of the statutory regulation of grade crossings in Illinois from the various reports of the Railroad and Warehouse Commission of the State, and from the report of the present consulting engineer, Mr. Dwight C. Morgan, for the year 1895). Eng News–Feb. 6. 2800 w.

4028. Some Railroad Matters in England. W. M. Acworth (Communication on light railways, rates on farm products, and other items of interest). R R Gaz–Feb. 7. 2300 w.

4032. Recent Improvements in Design and Construction of Locomotives (The latest practice in boiler construction is given special attention). R R Gaz–Feb. 7. Serial. 1st part. 2000 w.

4052. Some Interesting Facts Relative to the Double Trolley System. Bert L. Baldwin, with editorial (The successful working of this system in Cincinnati, with the advantages, and objections are considered. The development of the system, with many illustrations). Elec–Feb 5. 2500 w.

SCIENTIFIC MISCELLANY

The X Rays—Professor Röntgen's Discovery.

Recent scientific developments almost incline thoughtful people who have followed them to believe that we are on the eve of very remarkable revelations. It is certain that a multitude of mysteries yet remain unpenetrated, and each new discovery becomes a powerful engine wherewith to delve further into mines that seem richer as men of science penetrate deeper into them. We now stand in possession of many secrets the discovery of which would have appalled investigators in the middle ages, and which they would not have dared even to hint, much less widely promulgate. Professor Röntgen, had he lived then, would probably have been burned at the stake as a sorcerer and a heretic. To what extent his recent discovery will reach in its effects upon scientific progress and upon industrial methods cannot yet be predicted, but some of the effects which seem obvious even at this early stage are noted in *The Engineering and Mining Journal* (Feb. 1). Another article by Hugo Münsterberg, of Harvard University, and an editorial note, both in *Science* (Jan. 31), define the present scientific status of the discovery and its probable practical importance. *Science* says, editorially:

"The transmission through wood and other substances of the rays from a Crookes vacuum tube, discovered by Professor Röntgen, is reported to have been confirmed by Professor Klupathy of Pesth, Prof. Domalip of Prague, Prof. Czermak of Gratz, and Mr. A. A. C. Swinton of London. The photographs have been exhibited before several scientific societies, and, by Prof. Röntgen, to the emperor of Germany, from whom he has received a decoration.

"Mr. Swinton writes to the *Standard* that, with Mr. J. C. M. Stanton, he has obtained distinct proof that the radiations in question do pass easily through various substances that are quite opaque to ordinary light, and do produce strong impressions upon ordinary photographic plates entirely encased in light-proof material. Indeed, all substances that he has so far experimented on in his laboratory appear to be transparent to these radiations, even sheets of ebonite, carbon, vulcanized fiber, copper, aluminum, and iron, though there is considerable variation in degree. It is thought that the new method of photography may have important applications, not only in surgery, but also in metallurgy, by revealing flaws, inequalities, and fractures in metals.

"Hertz discovered that cathode rays pass through metal films not translucent to ordinary light, and Dr. Lenard and others have published careful experiments on the subject. Attention has been called to Prof. Zeugen's having photographed Mt. Blanc, in 1885, by the cathode rays. Professor Röntgen, however, states that the rays discovered by him, which he calls X-rays, are not cathode rays, as they are not refrangible nor affected by magnetic influences, but that they are most probably longitudinal waves in the ether.

"While Hertz and Lenard hold that the cathode rays are vibrations in the ether or even light of short wave-length, Crookes and J. J. Thomson have urged that the rays are negatively-charged matter traveling with great velocity. M. Perrin reported to the Paris Academy, on December 30, experiments which tend to show that the latter view is correct, and some relation will probably be found between cathode rays and the X-rays."

Mr. Münsterberg thinks "it may be that the practical importance of the discovery is equal to the theoretical. It is well known throughout the world that the physical laboratories of Germany have no windows looking towards the patent office. The hunting for practical inventions is not usually important for theoretical science, but the progress of theory usually has practical applications. One practical result in this case is already clear; as the new rays pass boards, but not thick metal plates, so they pass the organic substances of the human body, such as skin, muscles, etc., but not the bones. As the metal weights in the wooden box can be photographed, so can photographs of the human bones be taken. Röntgen has put his hand between the tube and the dry plate in the closed camera; the photograph shows clearly all the bones of the hand without the flesh and skin, and the gold rings seem to hang in the air. The value of such a method for medical diagnosis is clear. Fractures and diseases of bones can be examined by photographic plates, and metal pieces in the body—for example, needles, bullets, etc.,—can be found by this method. It will be a matter of the future to learn whether the rays have psycho-physiological effects.

"The newspapers report that the whole thing was discovered by mere chance. Röntgen saw the effects on photographic papers, which by chance were near to a covered tube during the discharge. This chance origin is not probable, as Lenard, the assistant of Hertz, has been working in the same direction for a long time, and many preparatory experiments by Röntgen himself cleared slowly the way. But suppose chance helped. There were many galvanic effects in the world before Galvani saw by chance the contraction of a frog's leg on an iron gate. The world is always full of such chances, and only the Galvanis and Röntgens are few."

A Brooklyn physician suggests to us that certain diseases—osteosarcom, for example—may be found to so modify organic tissues normally permitting the free passage of the X-rays as to render them more or less opaque to these rays, and thus permit the boundaries and extent of the diseases to be mapped out, and their progress to be traced.

In the mechanic arts the discovery promises to be immediately fruitful. The article in *The Engineering and Mining Journal* contains important facts upon the behavior of the X-rays with the metals. Among these it is mentioned that aluminum and lead are translucent to the new rays, and that no two metals are alike in this respect. It says:

"Lead proves to be almost as translucent as aluminum or wood. Hitherto it has not been possible without a complicated process to test the uniformity of structure of metal work,—for instance, gun-barrels, iron rails, railroad wheels, etc., or to distinguish at sight the different varieties of iron and steel. All this, it is anticipated, will be shortly achievable by the help of the new photography. It is no exaggeration to say that this would mean the complete revolution of many branches of metallic industry, especially the manufacture of arms."

No more pronounced instance of the possibilities that lie in the discovery of any new physical fact can be found than in the history of this discovery and those which led up to it. This history might begin with Geissler's tubes. The next great step was made by Professor Crookes, who so far improved upon Geissler's methods as to attenuate matter in hermetically-sealed glass bulbs almost to the vanishing point. A series of astonishing results, previously unknown to the scientific world, soon followed, and the fame of the experimenter, already great through previous researches, rose to the highest point. Röntgen has now discovered what eluded even Professor Crookes. When the latter made public the results obtained by vacuum tubes, they appeared like a species of magic, so far removed from any industrial application (with perhaps the exception of the radiometer, subsequently proved to be misnamed) that "*Cui bono?*" was frequently reiterated by the sceptical, yet interested, public. This question is now about to receive its answer, and in a much shorter period than was then anticipated.

If our memory serves us, it is not much more than twenty-five years since Professor Crookes made known his modifications of the Geissler tubes. Instead of tubes, proper, he made use of egg-shaped glass bulbs, in which, by refined methods, he produced vacua much greater than had been gained by any previous experimenter.

A positive electric current is brought into the tube by a platinum wire fused into the glass (the anode); and at another point is placed another similar arrangement by which the current passes out,—the cathode. When an electric current passes through such a bulb, the interior becomes luminous, and certain special properties of the light-rays, which we will not here discuss, led to the use of the terms "anode-rays" and "cathode rays," as distinguishing the character of the light at the respective platinum terminals.

Many who have written about Professor Röntgen's discovery have called the light by which he has obtained his remarkable results "*cathode* rays," but he, himself, asserts that the light differs in important respects from the cathode rays, and states the differences. He gives to the newly-discovered light the name "X-rays."

The Lowest Temperature Yet Reached.

ACCORDING to the *Journal of Gas Lighting* the lowest temperature yet artificially produced has been obtained by Professor Olszewski, who has "recently determined the boiling point and the critical temperature of hydrogen; and the result shows that it is possible, by taking proper precautions, to do experimental work in the domain of physics at a point very near the absolute zero of temperature. The process is described in detail in *Wiedemann's Annalen.* The method of expansion, which had already been successfully employed to ascertain the critical pressure, was again utilized. The critical temperature being that at which liquid hydrogen, when slowly released from pressure, first boils up; and the boiling point is the temperature reached when the pressure is reduced to that of one atmosphere. The chief difficulty in these experiments is the thermometric one; and Professor Olszewski successfully overcame this by the employment of a thin platinum wire immersed in the liquid hydrogen, which, by its varying resistance, indicated the fall of the temperature. It is interesting to note, in connection with what has been stated with regard to the effect of cold upon the strength of materials, that Professor Olszewski used cast-iron cylinders brought down to a temperature of 210° C. (not far from absolute zero) by means of liquid oxygen, at which the cylinders still held oxygen compressed to 180 atmospheres. The critical temperature of the hydrogen was, however, still lower, and was not reached until 234.5°C. had been registered. The boiling point was 243.5°C., or 406.3°F. (probably the greatest cold ever attained by artificial means).

Expired Air and Problems of Ventilation.

UNDER this title in *Popular Science Monthly* are given the conclusions of three prominent men in the scientific world, which so conflict with previous views entertained by other students of ventilation, and even those formerly entertained by at least one of these gentlemen, that they at once challenge attention. The accuracy of the conclusions is likely to be questioned.

The gentlemen referred to are Dr. J. S. Billings (a well-known author of works upon heating and ventilation), Dr. S. Weir Mitchell, and Dr. D. H. Bergey. The conclusions—an abstract of which from the article above named follows—have been published in the Smithsonian contributions. We do not know that any of these gentlemen has ever expressed publicly any other view of the quality of expired air than those contained in this abstract, except Dr. Billings. He, at least, is on record as holding the opinion that carbonic acid, present in the atmosphere of an inclosed space, and produced by the respiration of warm-blooded animals, is a reliable indication of other and more poisonous exhalations, which, though they are not directly measurable,—or, at least, are very difficult to measure directly,—bear a practically constant relation to the amount of carbonic acid exhaled. This has been the generally-accepted view, and we confess that the experiments from which the contrary is inferred do not yet convince us of its fallacy. Certainly it has been found that an amount of carbonic acid generated from marble and sulphuric acid can be endured with impunity, which, if generated by respiration, would be accompanied by great discomfort.

In this new gospel of ventilation it is declared that there "is no peculiar organic matter which is poisonous to animals (excluding man) in the air expired by healthy mice, sparrows, rabbits, guinea-pigs, or men. The injurious effects of such air appeared to be due entirely to the diminution of oxygen or the increase of carbonic acid, or to a combination of these two factors. It is very improbable that the minute quantity of organic matter contained in the air expired from human lungs has any deleterious influence upon men who inhale it in ordinary rooms. In ordinary quiet respiration no bacteria are contained in the expired air. In the act of coughing or sneezing such organisms may be thrown out. The minute quantity of ammonia, or of combined nitrogen, or other oxidizable matters found in the condensed moisture of human breath appears to be largely due to products of the decomposition of organic matter which is constantly going on in the mouth and pharynx. The air in an inhabited room, such as a hospital ward, in which experiments were made, is contaminated from many sources besides the expired air of the occupants, and the most important of these contaminations are in the form of minute particles or dusts. The experiments on the air of the hospital ward showed that in this dust there were micro-organisms, including some of the bacteria which produce inflammation and suppuration, and it is probable that these were the only really dangerous elements in this air. The results of experiments, in which animals were compelled to breathe air vitiated by the products of either their own respiration or by those of other animals, make it improbable that there is any peculiar volatile poisonous matter in the air expired by healthy men and animals other than carbonic acid."

Again it is said: "The proportion of carbonic acid and of diminution of oxygen which has been found to exist in badly-ventilated churches, schools, theaters, or barracks is not sufficiently great to account for the discomfort which such conditions produce in many persons, and there is no evidence to show that such an amount of change in the normal proportion of these gases has any influence upon the increase of death-rates which statistical evidence has shown to exist among persons living in crowded and unventilated rooms. It has been well established by observation and statistics that tuberculosis and pneumonia are the diseases most prevalent among persons living and working in unventilated rooms. But consumption and pneumonia are caused by specific bacteria, which, for the most part, gain access to the air passages by adhering to particles of dust which are inhaled; and it is probable that the greater liability to these diseases of persons living in crowded and unventilated rooms is to a large extent due to the special liability of such rooms to become infected with germs of these diseases."

"The discomfort produced by crowded, ill-ventilated rooms in persons not accustomed to them is not due to the excess of carbonic acid, nor to bacteria, nor in most cases to dusts of any kind. The two great causes of such discomfort, though not the only ones, are excessive temperatures and unpleasant odors. The cause of the unpleasant musty odor which is perceptible to most persons on passing from the outer air into a crowded, unventilated room is unknown; it may, in part, be due to volatile products of decomposition contained in the expired air of persons having decayed teeth, foul mouths, or certain disorders of the digestive apparatus, and it is due in part to volatile fatty acids given off with, or produced from, excretions of the skin. The results of this investigation, taken in connection with the results of other recent researches, indicate that some of the theories upon which modern systems of ventilation are based are either without foundation or doubtful, and that the problem of securing comfort and health in inhabited rooms requires the consideration of the best method of preventing or disposing of dusts of various kinds, of properly regulating temperature and moisture, and of preventing the entrance of poisonous gases, like carbonic oxid, derived from heating and lighting apparatus, rather than upon simply diluting the air to a certain standard of proporiton of carbonic acid present."

Nevertheless, these investigators say that "it would be unwise" to depart from the standard of air-supply "based on the results of Pettenkofer's work." No reason why this would be unwise is given. If the theory hitherto held be all wrong, why should we adhere to a practice that has this theory for its only sanction?

The cause for the bad odor in all ventilated rooms is stated to be unknown. If so unknown, how is it known that the material which constitutes the odor is not injurious to health, or that it does not cause discomfort other than its offensiveness to the olfactory apparatus? These views, coming from such a source, are likely to give rise to an interesting debate.

Floating Sand.

BODIES of great specific gravity, when divided to such minuteness that a sufficiently large surface in proportion to the weight of the particles is secured, will float on water, the cohesion of the liquid surface sufficing to sustain these small weights without breaking under them. Thus gold precipitated from a solution of its terchlorid by methylic alcohol will float; or fragments of finely-beaten gold leaf will float indefinitely on the surface of pure distilled water. But particles of this sort are very much smaller than any kind of native sand, and something further is necessary to explain the phenomenon of sand floating on the surface of streams of water, described by Mr. Frederic W. Simonds in the *American Geologist* for January. The author of this interesting account says he observed this singular phenomenon during his stay with a camping party on the banks of the Llano river, a clear stream, tributary to the Colorado, flowing through what has been termed "the central mineral region." The sand formed from the disintegration of the rocks in this locality is "granite sand," though composed of vitreous and pink quartz with some other minor ingredients.

"The morning after my arrival, the river was found to be rising, and, as I stood on the bank, at the point where we secured our water supply, I noticed a considerable froth and what appeared to me, at the time, scum passing down the stream. I spoke of the condition of the river to my companion, Mr. Laurence D. Brooks, of Austin, who remarked that what seemed to be scum was really sand. I thereupon went down to the water's edge, and, dipping up some of the floating material, was astonished to find that the patches were composed of sand, mainly of quartz. At this time—half-past nine or ten—the water supported a large number of patches, which varied in area from less than a square inch up to several square inches, all swept along by the current.

"The phenomenon was witnessed only while the river was rising When the water began to recede, no more floating sand was seen. The reason for this will appear later.

"Noting my surprise, Mr. Brooks stated that he had seen sand floating on some of the streams of Alabama, and that it had oftentimes been very troublesome in digging water-holes. To test this statement I at once scooped out some holes in the damp sand, and, surely enough, as their sides caved in, a few grains floated away on the surface of the water which immediately filled the holes. Between the grains there seemed to exist a mutual attraction, in consequence of which they ultimately grouped themselves into small patches similar to the smaller patches seen on the river. In the meantime, Mr. Brooks, by gently sifting dry sand from his hands onto the water, succeeded in forming much larger patches.

"A week later, when the river was well down and the sandy stretches of its bed had become quite dry on their surface, I gathered sand by handfuls, and sent it floating down the stream in such quantities that the sand-rafts actually cast shadows on the bottom as they passed. Then I dug several large holes, as I had previously done in the damp sand, but with far better results, for, when their sides caved in, the dry grains forming the outer coat of the deposit were gently launched, and floated off much more abundantly. Futhermore, as each mass of sand slipped into the water and, exclusive of the floating grains, sank, the air contained in the interstices between the particles rose to the surface, forming a patch of foam or froth. The observations here made strong proof of the probable explanation of the phenomenon of floating sand from a geological standpoint, the physical explanation being quite a different matter."

The patches of floating sand observed on the Llano river are accounted for by the crumbling of its sandy banks whenever the water rises.

The same phenomenon was observed by Mr. James C. Graham on the Connecticut river in 1890, and reported in the December number of the *American Journal of Science* for that year. He accounted for it by the action of capillarity.

Experimenting with sand of quartz and other minerals, Mr. Simonds has since found that a considerable variety of sand will float, and he gives a tabulated statement of sands obtained from different localities,--their origin, composition, size and shape of grains, and behavior when gently thrown upon the surface of water. Out of fourteen different specimens thirteen float more or less markedly.

Mr. Simonds repeated his experiment with rain water, distilled water, Colorado river water, and river water boiled and filtered, and found no appreciable variation in their action. The attraction for each other of the undivided floating grains, which tends to aggregate them into floating patches, is one of the remarkable features of the phenomenon. Though scattered over a surface a foot in diameter, they ultimately formed a single raft.

Mr. Simonds gives, tentatively, his own explanation of the phenomenon as follows:

"When shaded, it will be seen that the floating sand grains cause a depression of the water's surface, which indeed is quite as apparent in the case of isolated grains as in that of patches. I recall one instance where the depression, of very short duration, possibly but a few seconds, was so great as to be positively startling. As I was sprinkling some sand upon the river, for experimental purposes, a pebble almost as large as the end of my little finger fell into the center of a floating patch, which, to my great astonishment and delight, was depressed like a funnel for, say, half an inch, before the cause of this unexpected phenomenon broke through the surface and sank to the bottom.

"It appears from these and other observations that the weight of the sand grains actually depresses the surface of the water; yet the elastic reaction of that surface is sufficiently great to prevent them from sinking, especially when the resistance offered by their angularity is taken into consideration. In the launching of grains the more rounded would tend to roll over in the water and thus become wet, in consequence of which they would sink, while those of an irregular shape would overcome the tendency to roll and remain partially dry, thus fulfilling a condition necessary for floating."

This is a good account of careful observations of a very interesting phenomenon that has hitherto attracted little attention, and which may have an important relation to the formation of channels and banks in rivers. Further study, however, may evolve a different theory of its cause; that above given does not seem entirely adequate.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

3573. Advice to Young Men Who Wish to Become Successful Engineers. W. H. Wakeman (Relates to education in schools and works). Lord's Mag-Jan. 2200 w.

*3591. The Bradford Technical College (Interesting description of a now famous English school). Engng-Jan. 3. Serial. 1st part. 1800 w.

*3625. Engineering Progress (One of the most comprehensive general reviews of progress in different branches of engineering, and in the industrial world, that has yet appeared). Eng, Lond-Jan. 3. 25000 w.

*3686. The French Universal Exposition of 1900. Count Alphonse de Calonne (An account principally of the difficulty in securing a suitable site, followed by a description of the locality decided upon, and the location of the exhibits). Arch Rec-Jan-March. 4000 w.

†3721. On the Photometry of Differently Colored Lights and the "Flicker" Photometer. Frank P. Whitman (Exceedingly interesting account of the development of a new photometric instrument and method, based on Prof. Rood's "flicker principle." Diagram representations of the new apparatus and curves of the relative luminosities of nineteen different colors are presented, as illuminated by a kerosene lamp, a grey sky, and a bright blue sky). Phys Rev–Jan-Feb. 2800 w.

†3723. On the Freezing-Points of Dilute Aqueous Solutions. E. H. Loomis (Describes the continuation of an elaborate series of experiments, with a tabulated presentation of the constants determined). Phys Rev–Jan-Feb. 6000 w.

3768. Prof. Roentgen's Alleged Discovery (Editorial on the claim that it is possible to photograph objects behind opaque substances. A review of what is reported as having been accomplished with comments). Elec–Jan. 22. 1800 w.

3783.—75 cts. Pyrometry: Calibration of the Le Chatelier Thermo-Electric Pyrometer. S. W. Holman (The usual method is described and a new and simplified method explained). Tech Quar–Oct. 4000 w.

*3799. On Flame Temperatures and the Acetylene Theory of Luminous Hydrocarbon Flames. Arthur Smithells (A paper read before the Chem. Soc. Topics discussed are the temperature gradients of flame; non-luminous hydrocarbon flames; luminous coal-gas flames; occurrence of acetylene in flames; comparison of different flames; the flames of acetylene; thermo-chemical considerations, and the alleged liberation of carbon from cyanogen in flames. The arguments of Prof. Lewes in support of the last named proposition are asserted to be invalid and an attempt is made to prove them so). Jour Gas Lght–Jan. 14. 5500 w.

*3819. The Metric System and Standard Screw Threads (Editorial discussion of a recommendation recently made by a committee of the House of Commons, that a law be passed making the adoption of the metric system in England compulsory within two years from its enactment. The benefits of the metric system are admitted, but the difficulties to be met in making such a change are formidable). Engng–Jan. 17. 2800 w.

3834. Chief Swenie on Fire-Fighting (First part deals with the increased and still increasing fire hazards, much of which increase is due to methods of heating and lighting unknown to previous generations, and also to new industries and modern methods of organizing industrial establishments, and current methods of constructing industrial buildings). Fire & Water–Jan. 25. Serial. 1st part. 2000 w.

3881. Dark Light Photography. C. J. Reed (An article on the alleged results of Prof. Röntgen in photographing without light). Elec Wld–Feb. 1. 1000 w.

†3887. Gathering Naval Stores. Lee J. Vance (The turpentine industry in the United States and its methods contrasted with French methods, the latter being considered much superior). Pop Sci M–Feb. 3800 w.

3902. The X-Rays. Hugo Münsterberg (A review of Prof. Röntgen's discovery, and an editorial note which shows that others have been at least on the threshold of the same discovery for some time. List of scientists in the United States and Europe who have repeated Prof. Röntgen's experiments with confirmatory results). Sci–Jan. 31. 1800 w.

3903. Roentgen's Discovery (Discusses the discovery by Prof. Roentgen of a kind of light which passes through bodies hitherto classed as opaque, and suggests some practical applications of the discovery in the arts). Eng & Min Jour–Feb. 1. 2500 w.

3909. Prof. Roentgen's Light (Comments by Prof. Edwin H. Hall, of Harvard College, upon the new discovery. Reprinted from the *N. Y. Sun*). Am Gas Lgt Jour–Feb. 3. 1500 w.

†3914. The Newest Telescope. C. A. Young (The Yerkes Telescope. The difficulties in obtaining achromatism in the object glasses of large refracting telescope are explained, and reference is made to the German experiments now in progress, and directed to securing this quality in a higher degree. A detailed description of this great instrument, and of the observatory in which it is placed is very interesting and shows in some degree, how even astronomical progress is linked with the mechanical and engineering progress of the age). N Amer Rev–Feb. 3800 w.

†3923. Researches in Acoustics. Alfred M. Mayer (Containing the variation of the modulus of elasticity with change of temperature as determined by the transverse vibration of bars at various temperatures. The acoustical properties of aluminum). Am Jour of Sci–Feb. 5000 w.

†3924. The Counter-twisted Curl Aneroid. Carl Barus (Account of an experimental research to determine effects of modifications of the Bourdon tube). Am Jour of Sci–Feb. 4500 w.

*3932. On Röntgen's Rays (Correspondence with *Nature* upon the new discovery by Alfred Schuster and J. T. Bottomley). Nature–Jan. 23. 1800 w.

*3933. On a New Kind of Rays W. C. Röntgen (In this paper the discoverer of the X-rays states their properties and gives definite information by which his experiments may be repeated). Nature–Jan. 23. 2800 w.

*3934. Professor Röntgen's Discovery. A. A. C. Swinton (The writer describes experiments confirmatory of Röntgen's discovery. He obtains better results with high frequency currents than with even a large sized Rhumkorff coil). Nature–Jan. 23. 800 w.

*3947. A New Integrator. A. Russell and H. H. P. Powles (Description of a cheap appliance to be used with an Amsler's planimeter for performing integration) Eng, Lond–Jan. 24. 1000 w.

*3961. Photographing the Unseen; or, the New Electro-Photography (Review of the discovery of Prof. Röntgen, with illustrations showing the results of his work). Elec Rev, Lond–Jan. 24. 1000 w.

*3962. Absorption of Cathode Rays. P. Lenard (Experiments in proof of assumptions made). Elec Rev, Lond–Jan. 24. Serial. 1st part. 1800 w.

*3966. On a New Form of Radiation. Wilhelm Konrad Röntgen (Preliminary communication to the Würzburg Physico-Medical Society). Elect'n–Jan. 24. 3500 w.

3978. Cathodographs by Prof. Wright, of Yale University (Illustrated account of experiments which were suggested by Prof. Röntgen's late discovery). Elec Eng–Feb. 5. 800 w.

3979. The Phenomena of the Cathode Rays.—Suggested Apparatus for their Production. Elihu Thompson (Suggests a novel method of constructing a cathode ray generator). Elec Eng–Feb. 5. 700 w.

3980. Photographs Taken by the Moore "Etheric" Light. Ill. (Results obtained by the employment of the direct lighting effects of vacuum tubes in the photography of objects in the usual manner). Elec Eng–Feb. 5. 600 w.

3982. The Roentgen Ray Photography. Edwin H. Hall (From the *N. Y. Sun.* A review of investigations that led up to the recent discovery by Roentgen). Elec Eng–Feb. 1. 1500 w.

3983. Photography of the Invisible Without the Aid of a Crookes' Tube. Ill. William James Morton (Results attained by the writer, showing that effects similar to those attained by Crookes' tubes, are not impossible without the employment of highly vacuous enclosures). Elec Eng–Feb. 5. 800 w.

3992 The Burning of Clays. Thomas Townsley (A practical discussion of means and methods of baking bricks, pottery, &c). Brick–Feb. 4000 w.

4002. Röntgen's Photographs. A. E. Dolbear (An article calling attention to the fact that this discovery had been predicated). Elec Wld–Feb. 8. 600 w.

4003. The New Photography (A résumé of matter thus far printed concerning the discovery. Also editorial). Elec Wld–Feb. 8. 3700 w.

4041. The Internal Temperature of Rocks (Temperatures at different depths in the shafts of the Hecla and Calumet Mining Co). Eng & Min Jour–Feb. 8. 400 w.

4044. James Dwight Dana. J. W. Powell (The contributions to knowledge due to the life work of this eminent scientist. Great as a zoölogist, greater as a mineralogist, but greatest as a geologist). Science–Feb. 7. 2200 w.

4045. Pasteur. George M. Sternberg (An able discourse on the life and achievements of Louis Pasteur, born at Dôle in the Department of Jura, France, Dec 27, 1822; died at Garches, a suburb of Paris, Sept. 28, 1895). Science–Feb. 7. 2500 w.

4046. Helmholtz. T. C. Mendenhall (Account of his life and scientific labors. An interesting account of the rise and final triumph of the doctrine of the interconvertibility of forces is comprised in this article). Science–Feb. 7. 3900 w.

4048. Water Supply of Niagara. Orrin E. Dunlap (Considering the danger of drawing off so much water for power purposes as to ruin the beauty of the cataract). W Elec–Feb. 8. 1200 w.

4051. Roentgen Rays. M. I. Pupin (Reviewing the former experiments on electric discharges through rarefied gases, and asserting the importance of Roentgen's discovery). Elec–Feb. 5. 1300 w.

†4056. The Use of Pure Gum Bandages in Surgery. Henry A Martin (The advantages of such bandages are explained, and cases where they are specially helpful are cited). Ind Rub Wld–Feb. 10. 3500 w.

†4059. India Rubber Statistics for 1895 (Interesting as showing the increase in the rubber industry both in this country and England). Ind Rub Wld–Feb. 10. 500 w.

†4060. India-Rubber Cement. George B. Scott (The uses of this cement and its promising future). Ind Rub Wld–Feb. 10. 700 w.

†4061. The Harmless Cheapening of Rubber Goods. Edward F. Bragg (Advocates the cheapening of production through improved processes, or machinery). Ind Rub Wld–Feb. 10. 800 w.

4063. The Invention Epoch in the Cotton Trade. Joseph Nasmith (An interesting address, upon some world famous inventions, delivered before the Manchester Asso. of Engs). Bos Jour of Com–Feb. 8. Serial. 1st part. 1800 w.

†4067. Lacroix' Axial Goniometer. N. H. Winchell (Illustrated description of an attachment to the microscope, with solution of an example for measuring the optic angle of minerals.) Am Geol–Feb. 600 w.

†4068. A Study of Some Gas-Producing Bacteria. A. A. Bennett and E. E. Pammel (Chemistry of gaseous bacterial products and excretions, together with a bibliography of the literature upon this subject). Jour of Am Chem Soc–Feb. 2400 w.

†4071. Note on the Use of Acetyline Gas as an Illuminant for Polariscopic Work. H. W. Wiley (Account of an experimental examination into the application of this illuminant to polariscopic work, resulting favorably to its usefulness). Jour of Am Chem Soc–Feb. 700 w.

†4072. Indirect Analysis. Edward K. Landis (New formula for analysis, applicable upon the supposition that the present atomic weights should be modified, and applicable to any case wherein the atomic weights are not the same). Jour of Am Chem Soc–Feb. 900 w.

†4074. High Pressure Gas Bottles. From paper by M. Périssé (Conditions under which explosions are likely to occur. Precautions to be observed in filling. Rules as to quantity permissible in bottles of given capacity. Government regulations, etc). Ind Engng–Jan. 4. 1200 w.

*4076. The Best Milling Systems From a paper by W. A. Holley, read before the Mich. Millers' Assn. (Hints by a practical miller which will aid in the production of the maximum quantity of high grade flour, from the minimum quantity of wheat The various systems in use are named and their common purpose is the same). Am Miller–Feb. 1500.

BOOKS OF THE MONTH

Carpenter, Rolla C. Heating and Ventilating Buildings. J. Wiley & Sons, New York. 1895. Cl. $3.

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